PHYSICO-THEOLOGY:

OR, A

DEMONSTRATION

OF THE

Being and *Attributes* of GOD,

FROM HIS

Works of Creation.

Being the SUBSTANCE of

Sixteen SERMONS

Preached in St. *Mary-le-Bow-Church*, *LONDON*;

At the Honourable Mr. *BOYLE*'s LECTURES,

in the Years 1711, and 1712.

With large *Notes*, & many curious *Observations*.

By W. DERHAM, Canon of *Windsor*, Rector of *Upminster* in *Essex*, and F.R.S.

Mala & impia consuetudo est contra Deos disputare, sive animo id fit, sive simulatè. Cicer. de Nat. Deor. L. 2. fine.

The Eighth Edition.

London Printed, and Re-printed in *Dublin*: By and for SAMUEL FAIRBROTHER, Bookseller, and are to be Sold at his Shop in *Skinner-Row*, opposite the *Tholsel*, 1727.

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TO THE

Most Reverend Father in GOD,

THOMAS,

Lord Archbishop of CANTERBURY,
Primate of all *ENGLAND*, &c.

The Surviving TRUSTEE of the Honourable
Mr. *BOYLE*'s LECTURES.

May it please Your GRACE,

I May justly put these LECTURES under Your Grace's Patronage, their Publication being wholly owing to You: For having the Honour to be a Member of The ROYAL SOCIETY, as well as a Divine, I was minded to try what I could do towards the Improve-

provement of Philosophical *Matters to* Theological *Uses; and accordingly laid a Scheme of what I have here Published a Part of, and when I had little else to do, I drew up what I had to say, making it rather the diverting Exercises of my* Leisure Hours, *than more serious* Theological Studies. *This Work, (although I made a considerable Progress in it at first, whilst a Novelty, yet) having no Thoughts of Publishing, I laid aside, until your* Grace, *being informed of my Design by some of my Learned Friends, both of the Clergy and Laity, was pleased to call me to the unexpected Honour of Preaching Mr.* Boyle's LECTURES: *An Honour I was little aware of in my Country-Privacy, and not much acquainted with Persons in High Stations, and not at all, particularly, with Your* Grace. *So that therefore as it pleased Your* Grace, *not only to confer an unsought profitable Honour upon me (a Stranger,) but also to continue it for Two Years, out of Your good Opinion of my Performance, in some Measure, answering Mr.* Boyle's *End; so I can do no less than make this publick, grateful Acknowledgment of Your* Grace's *Great and Unexpected Favour.*

But it is not my self alone; but the whole LECTURE *also is beholden to your* Grace's *kind and pious Endeavours. It was You that encouraged this Noble Charity, and assisted in the Settlement of it, in the Honourable* Founder's *Life-time; and since his Death, it was You that procured a more certain Salary for*

the LECTURERS, *paid more constantly and duly than it was before**.

These Benefits, as I my self have been a Sharer of, so I should be very ungrateful, should I not duly acknowledge, and repay with my repeated Thanks and good Wishes.

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* It may not only gratify the Reader's Curiosity, but also be of Use for preventing Encroachments in Time to come, to give the following Account of Mr. *Boyle*'s Lectures.

Mr. *Boyle*, by a Codicil, dated *July* the 28th, 1691, and annexed to his Will, charged his Messuage, or Dwelling-House, in St. *Michael's Crooked-Lane*, *London*, with the Payment of the clear Yearly Rents and Profits thereof, to some Learned Divine in *London*, or within the Bills of Mortality, to be Elected for a Term not exceeding Three Years, by his Grace the present Lord Archbishop of *Canterbury* (then Dr. *Tennison*) Sir *Henry Ashurst*, Sir *John Rotheram*, and *John Evelyn*, Esq. The Business he appointed those Lectures for, was, among others, *To be ready to satisfy real Scruples, and to answer such new Objections and Difficulties, as might be started, to which good Answers had not been made.* And also, *To Preach Eight Sermons in the Year*, viz, *the first* Monday *of* January, February, March, April, *and* May; *and of* September, October, *and* November. The Subject of these Sermons was to be, *The Proof of the Christian Religion against Notorious Infidels*, viz. *Atheists, Theists, Pagans, Jews, and Mahometans; not descending lower to any Controversies that are among Christians themselves.* But by Reason the Lecturers were seldom continued above a Year, and that the House sometimes stood empty, and Tenants brake, or failed in due Payment of their Rent, therefore the Salary sometimes remained long unpaid, or could not be gotten without some Difficulty: To remedy which Inconvenience, his present Grace of *Canterbury* procured a Yearly Stipend of 50 *l.* to be paid Quarterly for Ever, charged upon a Farm in the Parish of *Brill*, in the County of *Bucks*: Which Stipend is accordingly very duly paid, when demanded, without Fee or Reward.

And that the Infinite Rewarder of well-doing, may give Your Grace *a plentiful Reward of these, and Your many other, both Publick and Private Benefactions, is the hearty Wish of*



Your GRACE's

Most Humble and Thankful

Son and Servant,

W. Derham.

TO THE READER.

AS the noble *Founder* of the *LECTURES* I have had the Honour of Preaching, was a great Improver of *Natural Knowledge*, ſo, in all Probability, he did it out of a Pious End, as well as in Purſuit of his *Genius*. For it was his ſettled Opinion, that nothing tended more to cultivate True Religion and Piety in a Man's Mind, than a thorough Skill in Philoſophy. And ſuch Effect it manifeſtly had in him, as is evident from divers of his publiſhed Pieces; from his conſtant Deportment in *never mentioning the Name of GOD without a Pauſe, and viſible Stop in his Diſcourſe*; and from the noble Foundation of his Lectures for the Honour of *GOD*, and the generous Stipend he allowed for the ſame. *Vid. Bp.* Burnet's *Funeral Serm. p.* 24.

And foraſmuch as his Lectures were appointed by him for the *Proof of the Chriſtian Religion againſt Atheiſts and other notorious Infidels*, I thought, when I had the Honour to be made his Lecturer, that I could not better come up to his Intent, than to attempt a Demonſtration of the *Being* and *Attributes of GOD*, in what I may call Mr. *Boyle*'s own, that is a *Phyſico-Theological* Way. And, beſides that it was for this very Service that I was called to this Honour, I was the more induced to follow this Method, by Reaſon none of my learned and ingenious Predeceſſors in theſe Lectures, have done it on purpoſe, but only caſually, in a tranſient, piece-meal Manner; they having made it their Buſineſs to prove the great Points of Chriſtianity in another Way, which they have accordingly admirably done. But conſidering what our *Honourable Founder*'s Opinion was of *Natural Knowledge*, and that his Intent was, that thoſe Matters, by paſſing through divers Hands, and by being treated of in different Methods, ſhould take in moſt of what could be ſaid upon the Subject; I hope my Performance may be acceptable, although one of the Meaneſt.

Vid. Mr. Boyle's Will.

As for others, who have before me done ſomething of this kind; as *Merſenne* on *Geneſis*; Dr. *Cockburne* in his *Eſſays*; Mr. *Ray* in his *Wiſdom of God*, &c. and I may add the firſt of Mr. *Boyle*'s *Lecturers*, the moſt learned Dr. *Bentley*, in his *Boyle's Lectures*, the eloquent Archbiſhop of *Cambray*, [and I hear, the ingenious Monſieur *Perault* hath ſomething of this Kind, but never

ſaw

saw it:) I say, as to these learned and ingenious Authors, as the Creation is an ample Subject, so I industriously endeavoured to avoid doing over what they before had done; and for that Reason did not, for many Years, read their Books until I had finished my own. But when I came to compare what each of us had done, I found my self in many Things to have been anticipated by some or other of them, especially by my Friend, the late great Mr. *Ray*. And therefore in some Places I shorten'd my Discourse, and referr'd to them; and in a few others, where the Thread of my Discourse would have been interrupted, I have made use of their Authority, as the best Judges; as of Mr. *Ray*'s, for Instance, with Relation to the Mountains and their Plants, and other Products. If then the Reader should meet with any Thing mentioned before by others, and not accordingly acknowledged by me, I hope he will candidly think me no Plagiary, because I can assure him I have all along, (where I was aware of it,) cited my Authors with their due Praise. And it is scarce possible, when Men write on the same, or a Subject near a-kin, and the Observations are obvious, but that they must often hit upon the same Thing; And frequently this may happen from Persons making Observations about one, and the same Thing, without knowing what each other hath done; which indeed, when the first Edition of my Book was nearly printed off, I found to be my own Case, having (for want of Dr. *Hook*'s *Micrography* being at hand, it being a very scarce Book, and many Years since I read it,) given Descriptions of two or three Things, which

I thought had not been tolerably well obſerv'd before, but are deſcrib'd well by that curious Gentleman.

One is a *Feather*, the Mechaniſm of which we in the main agree in, except in his Repreſentation in *Fig.* 1. *Scheme* 22. which is ſomewhat different from what I have repreſented in my *Fig.* 18, *&c.* But I can ſtand by the Truth, though not the Elegance of my Figures. But as to the other Differences, they are accidental, occaſion'd by our taking the Parts in a different View, or in a different Part of a Vane; and to ſay the Truth, (not flattering my ſelf, or detracting from the admirable Obſervations of that Great Man,) I have hit upon a few Things that eſcap'd him, being enabled to do ſo, not only by the Help of ſuch Microſcopes as he made uſe of; but alſo by thoſe made by Mr. *Wilſon*, which exceed all I ever ſaw, whether of *Engliſh*, *Dutch*, or *Italian* Make; ſeveral of which Sorts I have ſeen and examined.

The other Thing we have both of us figur'd and deſcrib'd, is, *The Sting of a Bee or Waſp*; in which we differ more than in the laſt. But by a careful Re-examination, I find, that although Dr. *Hook*'s Obſervations are more Critical than any where before, yet they are not ſo true as mine. For as to the *Scabbard*, (as he calls it,) I could never diſcover any Beards thereon; and I dare be confident there are none, but what are on the two Spears. And as to the Point of the *Scabbard*, he hath repreſented it as tubular, or bluntiſh at the Top;

Top; but it really terminates in a ſharp Point, and the two Spears and the Poiſon came out at a Slit, or longiſh Hole, a little below the Top or Point. And as to the Spears, he makes them to be but one, and that the Point thereof lies always out of the *Scabbard*. But by a ſtrict Examination, they will be found to be two, as I have ſaid, and that they always lie within the *Scabbard*, except in ſtinging; as I have repreſented them, in *Fig.* 21. from the tranſparent Sting of a Waſp. And as to the Spear being made of Joints, and parted into two, as his *Fig.* 2. *Scheme* 16. repreſents, I could never upon a Review, diſcover it to be ſo, but imagine, that by ſeeing the Beards lying upon, or behind the Spears, he might take them for Joynts, and by ſeeing the Point of one Spear lie before the other, he might think the Spear was parted in two. But leſt the Reader ſhould think himſelf impoſed upon both by Dr. *Hook*, and my *Self*, it is neceſſary to be obſerv'd, that the *Beards* (or *Tenterhooks*, as Dr. *Hook* calls them) lie only on one Side of each Spear, not all round them; and are therefore not to be ſeen, unleſs they are laid in a due Poſture in the Microſcope, *viz.* ſide-ways, not under, or a-top the Spear.

The laſt Thing, (which ſcarce deſerves mention) is the Mechaniſm of the *Hair*, which Dr. *Hook* found to be ſolid, like a long Piece of Horn, not hollow, as *Malpighi* found it in ſome Animals. And I have found both thoſe Great Men to be in ſome Meaſure in the Right, the *Hair* of ſome Animals, or in ſome Parts of the Body, being

ing very little, if at all, tubular; and in others, particularly *Mice*, *Rats*, and *Cats*, to be as I have repreſented in my *Fig.* 14, &c.

And now if my Inadvertency in other Things hath no worſe Effect than it hath had in theſe, namely, to confirm, correct, or clear others Obſervations, I hope the Reader will excuſe it, if he meets with any more of the like kind. But not being conſcious of any ſuch Thing, (although probably there be many ſuch) I am more ſollicitous to beg the Reader's Candour and Favour, with Relation both to the *Text* and *Notes*: In the former of which, I fear he will think I have as much under-done, as in the latter over-done, the Matter: But for my Excuſe, I deſire it may be conſider'd, That the textual Part being Sermons, to be deliver'd in the Pulpit, it was neceſſary to inſiſt but briefly upon many of the Works of *GOD*, and to leave out many Things that might have been admitted in a more free Diſcourſe. So that I wiſh it may not be thought I have ſaid too much rather than too little for ſuch an Occaſion and Place. And indeed, I had no ſmall Trouble in expunging ſome Things, altering many, and ſoftening the moſt, and, in a Word, giving in ſome Meaſure the Whole a different Dreſs than what I had at firſt drawn it up in, and what it now appears in.

And as for the *Notes*, which may be thought too large, I confeſs, I might have ſhorten'd them, and had Thoughts of doing it, by caſting ſome of them into the Text, as an ingenious, learned

Friend

Friend advis'd. But when I began to do this, I found it was in a Manner to new-make all, and that I ſhould be neceſſitated to tranſcribe the greateſt Part of the Book, which (having no Aſſiſtant) would have been too tedious for me, being pretty well fatigu'd with it before. I then thought it beſt to pare off from ſome, and to leave out others, and accordingly did ſo in many Places, and would have done it in more, particularly in many of the *Citations* out of the *Ancients*, both Poets and others, as alſo in many of the *Anatomical Obſervations*, and many of my own and others Obſervations: But then I conſidered, as to the Firſt, that thoſe *Citations* do (many of them at leaſt) ſhew the Senſe of Mankind about *GOD*'s Works, and that the moſt of them may be acceptable to young Gentlemen at the Univerſities, for whoſe Service theſe Lectures are greatly intended. And as to the Anatomical Notes, and ſome others of the like Nature, moſt of them ſerve either to the Confirmation, or the Illuſtration, or Explication of the Text, if not to the learned, yet to the unskilful, leſs learned Reader; for whoſe Sake, if I had added more, I believe he would forgive me. And laſtly, as to the Obſervations of my ſelf, and ſome others, where it happens that they are long, it is commonly where a Neceſſity lay upon me of fully expreſſing the Author's Senſe, or my own, or where the Thing was new, and never before Publiſh'd; in which Caſe, it was neceſſary to be more Expreſs and Particular, than in Matters better known, or where the Author may be referr'd unto.

In

To the READER.

In the former Editions I promiſed *another Part I* Had *relating to the Heavens*, if I was thereunto encourag'd. And two large Impreſſions of this Book, having been ſold off, ſo as to admit of a Third before the Year was gone about; and hearing that it is tranſlated into two, if not three Languages; but eſpecially being importuned by divers Learned Perſons, both known and unknown, I have thought my ſelf ſufficiently engaged to perform that Promiſe; and have accordingly Publiſhed that Part.

So that I have now carry'd my *Survey* through moſt Parts of the viſible Creation, except the *Waters*, which are for the moſt Part omitted; and the *Vegetables*, which, for want of Time, I was forced to treat of in a perfunctory Manner. And to the Undertaking of the former of theſe, having receiv'd divers Sollicitations from Perſons unknown, as well as known, I think my ſelf bound in Civility to own their Favour, and to return them my hearty Thanks for the kind Opinion they have ſhewn of my other Performances, that they have encourag'd me to undertake this other Task. And accordingly I have begun it, and (as far as my Affairs will permit) have made ſome Progreſs in it: But Age and Avocations growing upon me, I begin to fear I ſhall ſcarce be able to finiſh it as I would, and therefore muſt recommend that ample and noble Subject to others, who have more Leiſure, and would do it better than I.

As to *Additions*, I have been much ſollicited thereto by divers curious and learned Perſons, who would

would have had me to insert some of their Observations, and many more of my own: But in a Work of this Nature, this would have been Endless; and although the Book would thereby be render'd much better, and more compleat, yet I could by no Means excuse so great an Injustice to the Purchasers of the former Editions. And therefore (except in the second Edition, where it was not easy to be avoided) few Additions or Alterations have been made, besides what were Typographical, or of small Consideration. Only in the third Edition I amended the first Paragraph of *Note* 1. *Chap.* 5. *Book* 1. concerning *Gravity*; and in the Fourth, *Page* 16, and 18, I inserted two Passages out of *Seneca*, that were inadvertently left out, and corrected many Things, that upon a careful Review, seem'd to want Amendment.

And lastly, as to the following *Analysis*, it was added at the Request of some of my learned and ingenious Friends; and although it might have been contracted, they would not suffer it to be so.

AN ANALYSIS OF THE Following Book.

THE Works of the Creation relating to our Terraqueous Globe, are such as are visible in the

1 Outworks or Appendages of the Globe, *viz.* these Three:
- 1. The Atmosphere
  - Composed of Air and Vapours, *Page* 4.
  - Useful to
    - Respiration and Animal Life, *ibid.*
    - Vegetation of Plants 9.
    - Conveyance of
      - The winged Tribes.
      - Sound 11.
    - The Functions of Nature.
    - Reflecting and Refracting Light 12.
  - Containing the
    - Winds, which are of great Use and Necessity
      - To the Salubrity and Pleasure of the Air 14.
      - In various Engines 18.
      - In Navigation.
    - Clouds and Rain: Of great Use to the
      - Refreshment of the Earth and the Things therein 20.
      - Origine of Fountains, according to some 23.
- 2. Light. Its
  - Fountain 26.
  - Wonderful Necessity and Use.
  - Improvement by Glasses 28.
  - Velocity.
  - Expansion 29.
- 3. Gravity.
  - Its great Benefit 33.
  - Cause of *Levity*, which is of great Use in the World 34.

Terraqueous Globe itself. Of which I take a View in General

- General of,
  - Its Spherical Figure, which is the moſt commodious in regard of,
    - Light 40.
    - Heat.
    - Lodgment of the [illegible]rs.
    - The Winds 41.
  - Its Bulk 43.
  - Its Motion. *ibid.*
    - Annual.
    - Diurnal.
  - Its Place and Diſtance from the Sun, and other Heavenly Bodies 46.
  - Its Diſtribution, ſo as to cauſe all the Parts of the Globe to
    - Balance each other 48.
    - Be helpful to one another.
  - The great Variety and Quantity of all Things ſerving for Food, Phyſick, Building, and every Uſe and Occaſion of all Ages, Places, and Creatures 54.
  - An Objection anſwered 55.
- Particular of the Earth; of its
- Conſtituent Parts, *viz.* Its
  - Soils and Moulds, neceſſary to the
    - Growth of various Vegetables 62.
    - Various Occaſions of Man, and other Animals 62.
  - Various Strata or Beds, affording Materials for
    - Tools.
    - Firing.
    - Building.
    - Dying, and thouſands of other Things 66.
    - Conveyance of the ſweet Fountain-Waters *ibid.*
  - Subterraneous Caverns and Vulcano's; of great Uſe to Countries where they are 69.
  - Mountains & Valleys, which are not rude Ruins, but Works of Deſign, inaſmuch as this Structure of the Earth is
    - The moſt beautiful and Pleaſant.
    - The moſt Salubrious: to ſome Conſtitutions, the Hills; to ſome, the Valleys 73.
    - Beſt to ſkreen us, and other Things 74.
    - Beneficial to the
      - Production of various Vegetables.
      - Harbour and Maintenance of various Animals 75.
      - Generation of Minerals and Metals 76.
    - Abſolutely neceſſary to the Conveyance of the Rivers; and in all Probability to the Origine of Fountains 80.
    - Concluſion againſt blaming GOD 87.
- Its Inhabitants; which are either *Senſitive* or *Inſenſitive*.

- Senſitive, ſome Things are
  - Common to all the Tribes, particularly theſe Ten:
    - I. The five Senſes and their Organs; the 87.
      - Eye, an admirable Piece of Mechaniſm in regard of
        - its Form, for the moſt [illegible] Spherical, which is beſt for
          - The Reception [illegible] bjects.
          - Motion of the E[illegible].
        - Situation in the moſt commodious Part of the Body of every Creature.
        - Motion, in ſome Animals,
          - Every Way.
          - Fixed; and the excellent Proviſion in that Caſe 93.
        - Size; which is in
          - All Creatures, according to their Occaſions.
          - Such as live Abroad in the Light, larger.
          - Such as live under Ground, leſs.
        - Number, in ſome Animals:
          - Two 96
          - More: Together with the wiſe Proviſion to prevent double Viſion.
        - Parts; ſome of which are viewed
          - Tranſiently, the Arteries, Veins, and ſome of the Muſcles and Tunicks.
          - More ſtrictly ſome of the
            - Muſcles, and the excellent Proviſion made for their peculiar Uſes, Equilibration, &c. 99.
            - Tunicks: Among which the various Apertures, Forms, and Poſitions of the Pupil are particularly noted 101.
            - Humours, eſpecially the prodigious Finery and Compoſition of the Cryſtalline, according to Mr. *Lewenhoeck*.
            - Nerves 108.
              - Optick.
              - Motory.
        - Guard and Security, provided for by
          - The Reparation of the Aqueous Humour.
          - Covering of the Eye-Lids.
          - Strong and curious Bones.
          - Hard and firm Tunicks.
          - Withdrawing them into their Heads 112.
      - Of Erect Viſion 114.
    - Hearing. Its

Organ,

- Organ, the Ear 115.
  - Double, enabling us to hear every Way, and a good Proviſion for the Loſs or Hurt of one.
  - Situated in the very beſt Place for Information, Security, a[illegible]ear the Eye and Brain.
  - The Fabrick [illegible]e
    - Outward E[illegible] which is in
      - All Creatures formed, guarded, placed, and every way accoutered according to their various Places and Occaſions 118.
      - Man ſuitable to his erect Poſture; and all its Parts, the *Helix*, *Tragus*, *Concha*, &c. admirably ſuited to the Reception and Meliorating of Sounds, and the Security of the Part.
    - Inward Ear: In which I take a View of the 122
      - Auditory Paſſage, curiouſly tunnelled, tortuous, and ſmooth; and being always open, is linedwith the nauſeous Ear-wax for a Guard.
      - Tuba Euſtachiana 124.
      - Bone, particularlyhard and context for Guard, and to aſſiſt the Sound.
      - Tympanum, and its Membrane, Muſcles, and four little Bones to correſpond to all Kinds of Sound.
      - Labyrinth, Semicircular Canals, Cochlea; all made with the utmoſt Art 129.
      - Auditory Nerves, one of which is ramified to the Eye, Tongue, Muſcles of the Ear, and to the Heart; whence a great Sympathy between thoſe Parts 131.
  - Object, Sound. Under which I conſider,
    - The Improvements thereof by the Wit of Man 132
    - Its great Neceſſity, and excellent Uſes 135.
    - Its Pleaſure, and the Power of Muſick 137.
- Smelling. In which Senſe theſe Things are remarkable, the
  - Noſtrils, always open, cartilaginous, and endowed with Muſcles 139.
  - Laminæ, ſerving for
    - A Guard againſt noxious Things 141.
    - The ſpreading of the Olfactory Nerves.
  - Prodigious Uſe of it in all, eſpecially ſome of the Irrationals 142.
- Taſte. The Things moſt remarkable in which Senſe are, the
  - Nerves ſpread about the Tongue and Mouth, with their Guard.

The Papillæ, neatly made 143.
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Whoſe Organ is the [illegible]es *ibid.*
Which is diſperſed through every Part of the Body, and the admirable Benefit thereof.
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The Parts concerned therein are
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Bronchi and Lungs, with their curious Arteries, Veins and Nerves 153.
Ribs, Diaphragm, and the ſeveral Muſcles concern'd,
Its Defects in the
Fœtus in the Womb 156.
Amphibious Creatures 157.
Some Animals in Winter.
III. The Motion of Animals: Concerning which I conſider
Tranſiently the
Muſcles, and their Structure, their Size, Faſtening to the Joynts, Motions, &c. 160.
Bones, and their curious Make 162.
Joynts, with their Form, Bandage and Lubricity 164.
Nerves, and their Origine, Ramifications and Inoſculations.
More particularly the Loco-Motive Act itſelf, which is
Swift or ſlow, with Wings, Legs many or few, or none at all, according to the various Occaſions and Ways of Animals Lives. As particularly in
Reptiles, whoſe Food and Habitation is near at hand.
Man and Quadrupeds, whoſe Occaſions require a larger Range, and therefore a ſwifter Motion 166.
Birds, and Inſects, whoſe Food, Habitation and Safety require yet a larger Range, and have accordingly a yet ſwifter Motion and direct Conveyance.
Geometrically & neatly performed by the niceſt Rules.
Well provided for by the

Duc

- Due Equipoise of the Body 168.
- Motive Parts being accurately placed with regard to the Center of the Body's Gravity, and to undergo their due Proportion of Weight and Exercise.

IV. The *Place* allotted to the several Tribes of Animals to Live and Act in; concerning which I observe that

- Their Organs are adapted to their Place 170.
- All Places habitable are duly stocked.
- Various Animals have their various Places; and the Wisdom thereof 171.

V. The Balance of Animals Numbers, so that the World is not

- Overstocked by their Increase.
- Depopulated by their Death.

Which is effected in

- The several Tribes of Animals by a due Proportion in the
  - Length of their Life 172.
  - Number of their Young, in
    - Useful Creatures being many.
    - Pernicious few.

Man very remarkable by the

- Different Length of his Life.
  - Soon after the Creation 174.
  - When the World was more, but not fully Peopled 175.
  - When it was sufficiently stocked, down to the present Time.
- Due Proportions of Marriages, Births and Burials 177
- Balance of Males and Females 178.

VI. The Food of Animals. In which the Divine Management and Providence appears in the 183.

- Maintaining such large Numbers of all Kinds of Animals on the Land, in the Seas, and divers Places too unlikely to afford sufficient Food.
- Adjustment of the Quantity of Food to the Number of Devourers, so that
  - There is not too much, so as to rot, and annoy the World 185.
  - The most Useful is the most Plentiful, and easiest Propagated *ibid.*
- Delight which the various Tribes of Animals have to the Varieties of Food, so that what is grateful to one, is nauseous to another: Which is a wise Means to cause
  - All Creatures to be sufficiently supplied.
  - All sorts of Food to be consumed.
  - The World to be kept sweet and clean by those Means 187.

Peculiar Food, that particular Places afford to the Creatures reſiding therein 188.
Curious Apparatus in all Animals for Gathering, and Digeſtion of their Food, *viz.* the
Mouth, nicely ſhaped [illegible]ood, &c. In
Some, little and nar[illegible] 193.
Some, with a large deep Inciſure.
Inſects very notable to catch, hold and devour Prey; to carry Burdens, to bore and build their Habitations 194.
Birds as notable, Horned in all. In ſome
Hooked for Rapine, climbing, &c. 196.
Sharp and ſtrong to pierce Trees, &c.
Long and ſlender to grope.
Long and broad to quaffer.
Thick and ſharp edged to huſk Grain.
Compreſſed to raiſe Limpets, &c.
Teeth, which are peculiarly hard, firmly inſerted in the Jaws, variouſly ſhaped in the ſame, and different Animals, deficient young Creatures, &c. 200
Salival Glands, commodiouſly placed for Maſtication and Deglutition *ibid.*
Muſcles and Tendons, ſerving to Maſtication, ſtrong and well lodged.
Gullet, ſized according to the Food; with curious Fibres, &c. 201.
Stomach, 202.
Which hath a curious Mechaniſm of Fibres, Tunicks, Glands, Nerves, Arteries and Veins.
Whoſe Faculty of Digeſtion by ſuch ſeeming weak Menſtruums is admirable.
Whoſe Size and Strength is conformable to the Nature of the Food, or Occaſions of Animals.
Which is in
Tame Animals but one.
Ruminants, Birds, &c. more.
Guts, whoſe Tunicks, Glands, Fibres, Valves, and Periſtaltick Motion deſerve Admiration 205.
Lacteals, together with the Impregnations from the Pancreas, Gall, Glands, and Lymphæducts.
Sagacity of all Animals in finding out, and providing Food. In
Man leſs remarkable for the ſake of his Underſtanding 207.
Inferiour Creatures. In ſuch as are

Some

- Come to mature Age, and are able to help themſelves, by their
  - Accurate Smell 208.
  - Natural Craft.
  - Hunting and groping out of Sight.
  - Seeing and Smelling at great Diſtances 210.
  - Climbing; the ſtrong Tendons and Muſcles acting therein.
  - Seeing in the dark.
- Helpleſs. As 212.
- Young Creatures
  - Man, born the moſt helpleſs of any, the Parents Reaſon, Hands, and Affection ſufficing.
  - Irrationals: For whoſe Young the Creator hath made a ſufficient Proviſion, partly by the
    - Parent-Animals own
      - Στοργὴ, and Diligence in Nurſing and Defending them 212.
      - Sagacity and Care in repoſiting their Eggs and Young, where Food and all Neceſſaries are to be found 214.
    - Ability of the Young themſelves to ſhift for, and help themſelves, with the little Helps of their Dams 215.
- Creatures deſtitute of Food at ſome Seaſons, or likely to want it, who
  - Are able to live long without Food 216.
  - Lay up Food before-hand.

VII. The Cloathing of Animals, which is 219.

- Suited to the Place and Occaſions of all. In
  - Man it is left to his own Reaſon and Art, joined with ſufficient Materials: Which is beſt for him.
    - Becauſe he may ſute his Cloathing to his Quality and Buſineſs 224.
    - For Perſpiration and Health ſake.
    - To exerciſe his Art and Induſtry.
    - To excite his Diligence in keeping himſelf ſweet and clean.
    - In being the Parent of divers Callings 225.
  - Irrationals: Who are either
    - Ready furniſhed with proper Cloathing.
      - On the dry Land with Hair, Fleeces, Furs, Shells, hard Skins, &c. 226.
      - In the the Air with Feathers, light, ſtrong and warm.
      - In the Waters with Scales, hard for Guard; ſmooth

for Paſſage; or with ſtrong Shells to guard ſuch as move more ſlowly 229.
Provide for themſelves by their Textrine, or Architechtonick Art. Of which under the next Branch.
Well garniſhed, being all Workman-like, compleat, in its Kind beautiful, being [illegible]id.
Adorned with gay, various and elegant Colours,
If ſordid, yet with exact Symmetry, and full of curious Mechaniſm.
VIII. The Houſes and Habitations of
Man, who is abundantly furniſhed with
Contrivance and Art to build and garniſh his Habitations 231.
Materials of all ſorts to effect his Works.
Irrationals, whoſe marvellous Inſtinct is manifeſted by the
Convenience of their Neſts and Habitations for the
Hatching and Education of their Young 234.
Guard and Defence of themſelves and their Young,
Fabrick of their Neſts, ſcarce imitable by Man, and ſhewn by their Contrivance and Make, being exactly ſuitable to their Occaſions, and made by
Putting only a few ugly Sticks, Moſs, Dirt, &c. together 237.
Building Combs according to the beſt Rules of Mathematicks
Weaving Webs, and making Caſes. For which Service the Parts of their Bodies, and Materials afforded by them are very conſiderable.
IX. Animals Self-Preſervation. For which there is always a Guard in proportion to the Dangers and Occaſions of their State. Which is obſervable in
Man, whoſe Reaſon and Art ſupplies the Defect of Natural Armature.
Irrational Creatures; who
As they are on one Hand ſufficiently guarded by their
Shells, Horns, Claws, Stings, &c. 245.
Changing their Colours.
Wings, Feet, and Swiftneſs.
Diving in, and tinging the Waters.
Ejecting Juices out of their Body.
Accurate Smell, Sight, and Hearing.
Natural Craft 249.
Uncouth Noiſe, ugly Geſticulations, and horrid Aſpect.
Horrible Stink and Excrements.

So

So on the other Hand can by their Strength, Sagacity, or natural Artifices entrap and captivate what is neceſſary for their Food and other Occaſions.

X. Animals Generation.
- Equivocal, is denied 251.
- Univocal, Which of
  - Man, is συγκόπτειας ὁ ἐνα, paſſed wholly by
  - Irrational Creatures, which is remarkable for their
  - Sagacity in chuſing the fitteſt Place for their Eggs and Young: Where it is obſervable what a
    - Compleat Order they obſerve.
    - Neat Apparatus their Bodies are provided with for this Purpoſe. 253.
    - Natural Venom they inject with their Eggs into Vegetables to pervert Nature, and produce Balls and Caſes 256.

Making Uſe of the fitteſt Seaſons, either
- All Seaſons 257.
- When Proviſions are moſt plentiful and eaſieſt had.

Due Number of Young 258.

Diligence and Concern for their Young, in point of
- Incubation 259.
- Safety and Defence 260.

Faculty of Nurſing their Young, by
- Suckling them. In which it is obſervable
  - How ſuitable this Food is.
  - How willingly parted with by all, even the moſt ſavage
  - What a compleat Apparatus in all Creatures of Dugs, &c.
- Putting Food in their Mouths, with their proper Parts for catching and conveying Food 262.
- Neither way, but by laying in Proviſions before-hand. 263

Having in the Fourth Book thus diſpatched the Decad of Things in common to the *Senſitive Creatures*, I take a View of their particular Tribes, *viz.* of
- *Man*; whom I conſider with relation to his
  - Soul. Concerning which, having curſorily mentioned divers Things, I inſiſt upon two as ſhewing an eſpecial Divine Management, the
    - Various Genii, or Inclinations of Men, which is a wiſe Proviſion for the Diſpatch for all the World's Affairs, and that they may be performed with Pleaſure 269.
    - Inventive Faculty. In which it is remarkable that

Its

- Its Compaſs is ſo large, extending to all Things of Uſe, and occaſioning ſo many ſeveral Callings.
- Things of greateſt Neceſſity and Uſe were ſoon and eaſily found out; but Things leſs Uſeful later, and dangerous Things not yet. Here of divers particular Inventions, with an Exhortation to exerciſe and improve our Gifts.

Body. In which the Things particularly remarked upon are the

- Erect Poſture 289.
- The moſt convenient for a Rational Being.
- Manifeſtly intended, as appears from the Structure of ſome particular Parts mentioned 292.
- Nice Structure of the Parts miniſtring thereto.
- Equilibration of all the Parts 293.
- Figure and Shape of Man's Body moſt agreeable to his Place and Buſineſs 294,
- Stature and Size, which is much the beſt for Man's State 295.
- Structure of the Parts, which are
- Without Botches and Blunders.
- Of due Strength.
- Of the beſt Form.
- Moſt accurately accommodated to their proper Offices.
- Lodgment of the Parts, as the
- Five Senſes 304.
- Hand.
- Legs and Feet.
- Heart.
- Viſcera.
- Several Bones and Muſcles, &c. 305.
- Covering of all with the Skin.
- Proviſion in Man's Body to
- Prevent Evils by the
- Situation of the Eyes, Ears, Tongue & Hand. 307
- Guard afforded all, eſpecially the principal Parts.
- Duplication of ſome Parts.
- Cure of Evils by means of
- Proper Emunctories 308.
- Diſeaſes themſelves making Diſcharges of Things more dangerous 310.
- Pain giving Warning, and exciting our Endeavours.
- Conſent of the Parts, effected by the Nerves, a Sam-

ple

ple whereof is given in the Fifth Pair, branched to the Eye, Ear, &c.
Political, ſociable State. For the Preſervation and Security of which the Creator hath taken Care by Variety of Mens
Faces 315.
Voices.
Hand-Writing.
Quadrupeds. Of which I take no Notice, but wherein they differ from Man, *viz.*
Prone Poſture, which is conſiderable for
The Parts miniſtring to it, eſpecially the Legs and Feet, fized and made in ſome for
Strength and ſlow Motion 322.
Agility and Swiftneſs.
Walking and Running.
Walking and Swimming.
Walking and Flying.
Walking and Digging.
Traverſing the Plains.
Traverſing Ice, Mountains, &c.
Its Uſefulneſs to
Gather Food 324.
Catch Prey.
Climb, Leap and Swim.
Guard themſelves.
Carry Burdens, Till the Ground, and other Uſes for Man.
Parts differing from thoſe of Man.
Head, wherein I conſider
Its Shape, commonly agreeable to the Animal's Motion 325.
The Brain, which is,
Leſſer than in Man 326.
Placed lower than the Cerebellum.
The Nictitating Membrane 327.
Carotid Arteries, and Rete Mirabile.
Nates.
Neck.
Anſwering the Length of the Legs 329.
Strengthened by the Whitleather.
Stomach 330.
Correſponding to the ſeveral Species.
Suited to their proper Food, whether Fleſh, Grain, &c.
Heart: Its

Ventricles

- Ventricles in ſome
  - One only 331.
  - Two.
  - Three, as ſome think.
- Situation nearer the midſt of the Body, than in Man.
- Want of the Faſtening of the Pericardium to the Midriff 333.

Nervous Kinds. A Sample of which is given in the different Correſpondence between the Head and Heart of Man and Beaſt, by the Means of the Nerves 335.

Birds. Concerning which I take a View of their

- Body and Motion; where I conſider
  - The Parts concerned in their Motion 339.
    - The Shape of the Body, made exactly for ſwimming in, and paſſing through the Air.
    - Feathers, which are
      - Moſt exactly made for Lightneſs and Strength.
      - All well placed in every Part, for the Covering and Motion of the Body.
      - Preened and dreſſed 340.
    - Wings, which are
      - Made of the very beſt Materials, *viz.* of *Bones*, light and ſtrong; *Joynts* exactly opening, ſhutting, and moving, as the Occaſions of Flight require; and the *Pectoral Muſcles*, of the greateſt Strength of any in the whole Body.
      - Placed in the niceſt Point of the Body of every Species, according to the Occaſions of Flight, Swimming or Diving.
    - Tail, which is well made, and placed to keep the Body ſteady, and aſſiſt in its Aſcents and Deſcents. 343.
    - Legs and Feet, which are made light for Flight, and incomparably accoutered for their proper Occaſions of
      - Swimming 344,
      - Walking,
      - Catching Prey.
      - Rooſting.
      - Hanging.
      - Wading and Searching the Waters.
      - Lifting them upon their Wings.
  - Motion it ſelf.
    - Performed by the niceſt Laws of Mechanicks.
    - Anſwering every Purpoſe and Occaſion.
  - Other Parts of the Body, *viz.* the Head,

- Head, remarkable for the commodious
  - Shape of it ſelf 346,
  - Forms of the Bill.
  - Site of the Eye and Ears.
  - Poſition of the Brain.
  - Structure of the
    - Larynx.
    - Tongue.
    - Inner-Ear.
  - Proviſion by Nerves in the Bill for taſting and diſtinguiſhing Food 350.
- Stomachs, one to
  - Macerate and prepare 351.
  - Grind and digeſt.
- Lungs incomparably made for
  - Reſpiration *ibid.*
  - Making the Body buoyant.
- Neck, which is made
  - In due Proportion to the Legs.
  - To ſearch in the Waters, and
  - To counterpoiſe the Body in Flight.

State. Of which I take Notice of three Things, *viz.* their

- Migration remarkable for
  - The Knowledge Birds have of
    - Their Times of Paſſage 354.
    - The Places proper for them.
  - Their Accommodation for long Flights by long, or elſe ſtrong Wings.
- Incubation, which is conſiderable for
  - The Egg, and its Parts 357.
  - Act it ſelf; that theſe Creatures ſhould betake themſelves to it, know this to be the Way to produce their Young, and with Delight and Patience ſit ſuch a due Number of Days.
  - The Neglect of it in any, as the Oſtrich, and the wonderful Proviſion for the Young in that Caſe 360.
- Nidification. Of which before.

Inſects. Which altho' a deſpiſed Tribe, doth in ſome Reſpects more ſet forth the Infinite Power and Wiſdom of the Creator, than the larger Animals.

The Things in this Tribe remarked upon are their

- Body 365.
  - Shaped, not ſo much for long Flights, as for their Food, and Condition of Life.
  - Built not with Bones, but with what ſerves both for Bones and Covering too.

Eyes,

Eyes, reticulated to ſee all Ways at once 367.
Antennæ, and their Uſe *ibid.*
Legs and Feet made for
- Creeping 369.
- Swimming and Walking.
- Hanging on ſmooth Surfaces.
- Leaping.
- Digging.
- Spinning and Weaving Webs and Caſes.

Wings, which are
- Nicely diſtended with Bones 371.
- Some incomparably adorned with Feathers and elegant Colours.
- Some joynted and folded up in their Elytra, and diſtended again at Pleaſure.
- In Number either
  - Two, with Poiſes.
  - Four, without Poiſes.

Surprizing Minuteneſs of ſome of thoſe Animals themſelves, eſpecially of their Parts, which are as numerous and various as in other Animal Bodies 373.

State: which ſets forth a particular Concurrence of the Divine Providence, in the wiſe and careful Proviſion that is made for their

Security againſt Winter, by their
- Subſiſting in a different, *viz.* their Nympha or Aurelia State 376.
- Living in Torpitude, without any Waſte of Body or Spirits *ibid.*
- Laying up Proviſion before-hand.

Preſervation of their Species by their
- Chuſing proper Places, to lay up their Eggs and Sperm, ſo that the
  - Eggs may have due Incubation 380.
  - Young ſufficient Food.
- Care and Curioſity in repoſiting their Eggs in neat Order, and with the proper Part uppermoſt 388.

Incomparable Art of Nidification, by being endow'd with
- Parts proper for, and agreeable to the ſeveral Ways of Nidification, and the Materials they uſe in it.
- Architectonick Sagacity to build and weave their Cells, or to make even Nature herſelf their Handmaid 391.

Reptiles.

Reptiles. Which agreeing with other Animals in ſomething or other before treated of, I conſider only their
- Motion, which is very remarkable, whether we conſider the
  - Manner of it, as
    - Vermicular 400.
    - Sinuous.
    - Snail-like.
    - Caterpillar-like.
    - Multipedous.
  - Parts miniſtring to it.
- Poiſon, which ſerves to
  - Scourge Man's Wickedneſs 404.
  - Their eaſie Capture and Maſtery of their Prey.
  - Their Digeſtion.

Watery Inhabitants conſiderable for their
- Great Variety 407.
- Prodigious Multitudes.
- Vaſt Bulk of ſome, and ſurprizing Minuteneſs of others *ibid.*
- Incomparable Contrivance and Structure of their Bodies.
- Supplies of Food.
- Reſpiration.
- Adjuſtment of their Organs of Viſion to their Element.
- Poiſe and Motion of the Body every Way 408.

Inſenſitive Inhabitants. Among which having mentioned Foſſils and others, I inſiſt only upon *Vegetables*, and that in a curſory Manner upon their
- Great Variety for the ſeveral Uſes of the World 410
- Anatomy.
- Leaves 412.
- Flowers, and their admirable Gaiety.
- Seed, remarkable for its
  - Generation.
  - Make.
  - Containing in it a compleat Plant 414.
  - Preſervation and Safety in the Gems, Fruit, Earth, &c.
  - Sowing, which is provided for by Down, Wings, Springy Caſes, carried about by Birds, ſown by the Husbandman, &c. 418.
- Growing and Standing: Some by
  - Their own Strength 423.
  - The Help of others, by claſping about, or hanging upon them.

Remarkable Uſe, eſpecially of ſome which ſeem to be provided for the Good of All

{ All Places 425.
{ Some particular Places, to
{ Heal some Local Distempers.
{ Supply some Local Wants.

Practical Inferences upon the Whole are these Six, *viz.* That GOD's Works

1. Are Great and Excellent 430.
2. Ought to be enquired into, with a Commendation of such as do so 432.
3. Are manifest to all, and therefore *Atheism* unreasonable 433.
4. Ought to excite Fear and Obedience 436.
5. Ought to excite Thankfulness 438.
6. Should move us to pay God his due Homages and Worship, particularly that of the Lord's Day: which is an Appointment

{ The most Ancient 444.
{ Wisely contrived for Dispatch of Business, and to prevent Carnality.
{ Whose proper Business is, to cease from Worldly, and to follow Spiritual Employments; the Chief of which is the Publick Worship of GOD.



A SURVEY OF THE Terraqueous Globe.

INTRODUCTION.

IN *Pſal.* cxi. 2. The Pſalmiſt aſſerts, That *the* (*a*) *Works of the Lord are great; ſought out of all them that have Pleaſure therein.* This is true of all *God's Works*, particularly of his *Works of Creation*: Which when *ſought out*: or, as the *Hebrew* Word (*b*) ſignifieth, when *heedfully* and *deeply pried into, ſolicitouſly obſerved and enquired out*, eſpecially when clearly diſcovered

(*a*) It is not unlikely that the Pſalmiſt might mean, at leaſt have an Eye to, *the Works of the Creation* in this Text, the Word מעשה being the ſame that in *Pſal.* 19. 1. is tranſlated *God's Handy-work*, which is manifeſtly applied to the Works of *Creation*, and properly ſignifieth *Factum, Opus, Opificium*, from עשה *Fecit, Paravit, Aptavit.* And ſaith *Kircher, Significat talem affectionem, quâ aliquid exiſtit vel realiter, vel ornatè, vel ut non ſit in priſtino ſtatu quo fuit.* Concord. p. 2. col. 931.

(*b*) דרש *Quæſivit, perquiſivit, ſciſcitatus eſt.* Buxtor. in verb. *Et ſimul importat curam, & ſolicitudinem.* Conrad. Kirch. ib. p. 1. col. 1174.

to us; in this Caſe, I ſay, we find thoſe Works of God abundantly to deſerve the *Pſalmiſt*'s Character of being *Great* and *Noble*; inaſmuch, as they are made with the moſt exquiſite Art, (*c*) contrived with the utmoſt Sagacity, and ordered with plain wiſe Deſign, and miniſtring to admirable Ends. For which reaſon St. *Paul* might well affirm of thoſe ποιήματα of God, (*d*) That the *inviſible Things of God, even his eternal Power and Godhead, are underſtood by them.* And indeed they are the moſt eaſy, and intelligible Demonſtrations of the *Being* and *Attributes* of God; (*e*) eſpecial-

(*c*) *Quod ſi omnes mundi partes ita conſtitutæ ſunt, ut neque ad uſum meliores potuerint eſſe, neque ad ſpeciem pulchriores; videamus utrùm ea fortuita ſint, an eo ſtatu, quo cohærere nullo modo potuerint, niſi ſenſu moderante divinâque providentiâ. Si ergo meliora ſunt ea quæ Naturâ, quàm illa, quæ Arte perfecta ſunt, nec Ars efficit quid ſine ratione; ne Natura quidem rationis expers eſt habenda. Qui igitur convenit, ſignum, aut tabulam pictam cùm adſpexeris, ſcire adhibitam eſſe artem; eumque procul curſum navigii videris, non dubitare, quin id ratione atque arte moveatur: aut cùm Solarium, &c. Mundum autem, qui & has ipſas artes, & earum artifices, & cuncta complectatur, conſilii & rationis eſſe expertem putare? Quid ſi in Scythiam, aut in Britanniam, Sphæram aliquis tulerit hanc, quam nuper familiaris noſter effecit Poſidonius, cujus ſingulæ converſiones idem efficiunt in Sole, &c. —— quod efficitur in cœlo ſingulis diebus & noctibus; quis in illâ barbarie dubitet, quin ea Sphæra ſit perfecta Ratione? Hi autem dubitant de Mundo, ex quo & oriuntur, & ſiunt omnia, caſune ipſe ſit effectus, — an Ratione, an Mente divinâ? Et Archimedem arbitrantur plus valuiſſe in imitandis Sphæræ converſionibus, quàm Naturam in efficiendis, præſertim cùm multis partibus ſint illa perfecta, quam hæc ſimulata, ſolertius, &c.* Cic. de Nat. l. 2. c. 34, 35.

(*d*) And a little before he ſaith of *Nature* it ſelf, *Omnem ergo regit Naturam ipſe* [Deus] *&c.*

(*e*) *Mundus codex eſt Dei, in quo jugiter legere debemus.* Bernard. Serm.

Arbitror nullam gentem, neque Hominum ſocietatem, apud quos ulla Deorum eſt religio, quidquam habere ſacris Eleuſiniis aut Samothraciis ſimile: Ea tamen obſcurè docent quæ profitentur: Naturæ verò opera in omnibus animantibus ſunt perſpicua. Galen. de Uſ. Part. l. 17. c. 1.

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ly to ſuch as are unacquainted with the Subtilties of Reaſon and Argumentation; as the greateſt Part of Mankind are.

It may not therefore be unſuitable to the Nature and Deſign of Lectures (*f*) founded by one of the greateſt Vertuoſo's of the laſt Age, and inſtituted too on Purpoſe for the Proof of the Chriſtian Religion againſt Atheiſts, and other Infidels, to improve this Occaſion in the Demonſtration of the *Being* and *Attributes* of an infinitely wiſe and powerful Creator, from a Curſory Survey of the Works of *Creation*, or [as often called] of *Nature*.

Which Works belong either to our *Terraqueous Globe*, or the *Heavens*.

I ſhall begin with our *own Globe*, being neareſt, and falling moſt under our Senſes. Which being a Subject very various and copious, for the more methodical and orderly proceeding upon it, I ſhall diſtribute the Works therein:

I. Into ſuch as are not properly Parts, but *Appendages* or *Out-works* of the *Globe*.

II. The *Globe* it ſelf.

(*f*) *Philoſophia eſt Catechiſmus ad Fidem.* Cyril. 1. contr. Jul.

BOOK I.

Of the Out-Works of the Terraqueous Globe; the Atmosphere, Light, and Gravity.

Chap. I. *Of the Atmosphere in General.*

THE Atmosphere, or Mass of Air, Vapours and Clouds, which surrounds our Globe, will appear to be a Matter of Design, and the infinitely wise Creator's Work, if we consider its *Nature* and *Make* (*a*), and its *Use* to the World (*b*).

1. Its Nature and Make, a Mass of Air, of subtile penetrating Matter, fit to pervade other Bodies, to penetrate into the inmost Recesses of Nature, to excite, animate, and spiritualize; and in short, to be the very Soul of this lower World. A Thing consequently,

2. Of greatest Use to the World, useful to the Life, the Health, the Comfort, the Pleasure, and Business of the Whole Globe. It is the Air the whole Animal World breatheth, and liveth by; not only the Animals inhabiting the Earth (*c*) and Air,

(*a*) *Mundi pars est Aer, & quidem necessaria: Hic est enim qui cœlum terramque connectit, &c.* Senec. Nat. Qu. l. 2. c. 4.

(*b*) *Ipse Aer nobiscum videt, nobiscum audit, nobiscum sonat; nihil enim eorum sine eo fieri potest, &c.* Cic. de Nat. Deor. l. 2. c. 33.

(*c*) As the Air is of absolute Necessity to Animal Life, so it is necessary that it should be of a due Temperament or Con-

Conſiſtence; not foul, by reaſon that ſuffocateth; not too rare and thin, becauſe that ſufficeth not: with Examples of each of which, I ſhall a little entertain the Reader. In one of Mr. *Hawksbee*'s Compreſſing Engines, I cloſely ſhut up a *Sparrow*, without forcing any Air in; and in leſs than an Hour the Bird began to pant, and be concerned; and in leſs than an Hour and Half to be ſick, vomit, and more out of Breath; and in two Hours time was nearly expiring.

Another I put in and compreſſed the Air, but the Engine leaking, I frequently renewed the Compreſſure; by which Means, (although the Bird panted a little after the firſt Hour,) yet after ſuch frequent Compreſſures, and Immiſſion of freſh Air, it was very little concerned, and taken out ſeemingly unhurt after three Hours.

After this I made two other Experiments in compreſſed Air, with the Weight of two Atmoſpheres injected, the Engine holding tight and well; the one with the *Great-Titmouſe*, the other with a *Sparrow*. For near an Hour they ſeemed but little concerned; but after that grew falnter, and in two Hours time ſick, and in three Hours time died. Another Thing I took Notice of, was, that when the Birds were ſick, and very reſtleſs, I fancied they were ſomewhat relieved for a ſhort Space, with the Motion of the Air, cauſed by their fluttering and ſhaking of their Wings, (a Thing worth trying in the *Diving-Bell*.) I ſhall leave the ingenious Reader to judge what the Cauſe was of both the Birds living longer in compreſſed, than uncompreſſed Air; whether a leſs Quantity of Air was not ſooner fouled and rendred unfit for Reſpiration, than a greater.

From theſe Experiments two Things are manifeſted; one is, that Air, in ſome meaſure compreſſed, or rather heavy, is neceſſary to Animal Life: Of which by and by. The other, that freſh Air is alſo neceſſary; for pent-up Air, when overcharged with the Vapours emitted out of the Animal's Body, becomes unfit for Reſpiration. For which Reaſon, in the *Diving-Bell*, after ſome time of ſtay under Water, they are forced to come up and take in freſh Air, or by ſome ſuch Means recruit it. But the famous *Cornelius Drebell* contrived not only a Veſſel to be rowed under Water, but alſo a Liquor to be carried in that Veſſel, that would ſupply the want of freſh Air. The Veſſel was made for King *James* I. It carried Twelve Rowers, beſides the Paſſengers. It was tried in the River of *Thames*; and one of the Perſons that was in that ſubmarine Navigation was then alive, and told it one, who related the Matter to our famous Founder, the Honourable, and moſt Ingenious Mr. *Boyle*. As to the Liquor, Mr. *Boyle* ſaith, he diſcover-

ed by a Doctor of Phyſick, who married *Drebell*'s Daughter, that it was uſed from time to time when the Air, in the ſubmarine Boat, was clogged by the Breath of the Company, and thereby made unfit for Reſpiration; at which time, by unſtopping a Veſſel full of this Liquor, he could ſpeedily reſtore to the troubled Air ſuch a Proportion of vital Parts, as would make it again for a good while fit for Reſpiration. The Secret of this Liquor *Drebell* would never diſcloſe to above one Perſon, who himſelf aſſured Mr. *Boyle* what it was. *Vide* Boyle's *Exp. Phyſ. Mech. of the Spring of the Air*, *Exp.* 41. in the *Digreſſion*. This Story I have related from Mr. *Boyle*, but at the ſame time much queſtion, whether the Virtues of the Liquor were ſo effectual as reported.

And as too groſs, ſo too rare an Air is unfit for Reſpiration. Not to mention the forced Rarefactions made by the Air-Pump, in the following Note; it is found, that even the extraordinary natural Rarefactions, upon the tops of very high Hills, much affect Reſpiration. An Eccleſiaſtical Perſon, who had viſited the high Mountains of *Armenia*, (on which ſome fancy the Ark reſted) told Mr. *Boyle*, that whilſt he was on the upper Part of them, he was forced to fetch his Breath oftner than he was wont: And taking Notice of it when he came down the People told him, that it was what happen'd to them when they were ſo high above the Plane, and that it was a common Obſervation among them. The like Obſervation the ſame Eccleſiaſtick made upon the top of a Mountain in the *Cevennes*. So a learned Traveller, and curious Perſon, on one of the higheſt Ridges of the *Pyrenees*, call'd *Pic de Midi*, found the Air not ſo fit for Reſpiration, as the common Air, but he and his Company were fain to breath ſhorter and oftner than in the lower Air. *Vide Phil. Tranſact.* No. 63. or *Lowthorp*'s *Abridg.* Vol. 2. p. 226.

Such another Relation the learned *Joſeph Acoſta* gives of himſelf, and his Company, that, when they paſſed the high Mountains of *Peru*, which they call *Periacaca*, (to which he ſaith, *the* Alps *themſelves ſeemed to them but as ordinary Houſes, in regard of high Towers,*) *He, and his Companions, were ſurprized with ſuch extreme Pangs of Straining and Vomiting, (not without caſting up of Blood too,) and with ſo violent a Diſtemper, that he concludes he ſhould undoubtedly have died; but that this laſted not above three or four Hours, before they came into a more convenient and natural Temperature of the Air.* All which he concludes, proceeded from the too great Subtilty and Delicacy of the Air, which is not proportionable to humane Reſpiration, which requires a more groſs and temperate Air. *Vide Boyle, ubi ſupra.*

Thus

Air, (*d*), but those of the Waters (*e*) too. Without

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b Thus it appears, that an Air too Subtile, Rare and Light, is unfit for Respiration: But the Cause is not the Subtilty, or too great Delicacy, as Mr. *Boyle* thinks, but the too great Lightness thereof, which renders it unable to be a Counterbalance, or an Antagonist to the Heart, and all the Muscles ministring to *Respiration*, and the *Diastole* of the Heart. Of which see Book 4. Chap. 7. Note 1.

And as our Inability to live in too rare and light an Air, may discourage those vain Attempts of Flying, and Whimsies of passing to the Moon, &c. so our being able to bear an heavier State of the Air is an excellent Provision for Mens Occasions in Mines, and other great Depths of the Earth; and those other greater Pressures made upon the Air, in the *Diving-Bell*, when we descend into great Depths of the Waters.

(*d*) That the Inhabitants of the Air, (Birds and Insects,) need the Air as well as Man, and other Animals, is manifest from their speedy dying in too feculent, or too much rarefied Air; of which see the preceding and following Note *f*. But yet Birds and Insects (some Birds at least) can live in a rairer Air than Man. Thus Eagles, Kites, Herons, and divers other Birds, that delight in high Flights, are not affected with the Rarity of the Medium, as those Persons were in the preceding Note. So Insects bear the Air-Pump long, as in the following Note *f*.

(*e*) Creatures inhabiting the Waters need the Air, as well as other Animals, yea, and fresh Air too. The *Hydrocanthari* of all Sorts, the *Nymphæ* of *Gnats*, and many other Water-Insects, have a singular Faculty, and an admirable Apparatus, to raise their back Parts to the top of the Waters, and take in fresh Air. It is pretty to see, for Instance, the *Hydrocanthari* come and thrust their Tails out of the Water, and take in a Bubble of Air, at the tip of their *Vaginæ* and Tails, and then nimbly carry it down with them into the Waters; and, when that is spent, or fouled, to ascend again and recruit it.

So Fishes also are well known to use Respiration, by passing the Water through their Mouths and Gills. But *Carps* will live out of the Water, only in the Air; as is manifest by the Experiment of their way of Fatting them in *Holland*, and which hath been practised here in *England*, *viz.* they hang them up in a Cellar, or some cool Place, in wet Moss in a small Net, with their Heads out, and feed them with white Bread soaked in Milk, for many Days. This was told me by a Person very curious, and of great Honour and Eminence, whose

it moſt Animals live ſcarce half a Minute (*f*); and others, that are the moſt accuſtomed to the want of it, live not without it many Days. And

Word (if I had leave to name him) no Body would queſtion: And it being an Inſtance of the Reſpiration of Fiſhes very ſingular, and ſomewhat out of the way, I have for the Reader's Diverſion taken notice of it.

(*f*) By Experiments I made my ſelf in the Air-Pump, in *September* and *October*, 1704, I obſerved that Animals whoſe Hearts have two *Ventricles*, and no *Foramen Ovale*, as Birds, Dogs, Cats, Rats, Mice, &c. die in leſs than half a Minute counting from the very firſt Exſuction; eſpecially in a ſmall Receiver.

A *Mole* (which I ſuſpected might have born more than other Quadrupeds) died in one Minute (without Recovery) in a large Receiver; and doubtleſs would hardly have ſurvived half a Minute in a ſmall Receiver. A *Bat* (although wounded) ſuſtained the Pump two Minutes, and Revived upon the re-admiſſion of the Air. After that, he remained four Minutes and a half, and revived. Laſtly, After he had been five Minutes, he continued gaſping for a Time, and after twenty Minutes I re-admitted the Air, but the *Bat* never revived.

As for *Inſects*: *Waſps*, *Bees*, *Hornets*, *Graſſoppers*, and *Lady-Cows* ſeemed dead in appearance in two Minutes, but revived in the open Air in two or three Hours time, notwithſtanding they had been in *Vacuo* twenty four Hours.

The *Ear-wig*, the great *Staphylinus*, the great black lowſy *Beetle*, and ſome other Inſects would ſeem unconcerned at the *Vacuum* a good while, and lie as dead; but revive in the Air, although ſome had lain ſixteen Hours in the exhauſted Receiver.

Snails bear the Air-Pump prodigiouſly, eſpecially thoſe in Shells; two of which lay above twenty four Hours, and ſeemed not much affected, The ſame Snails I left in twenty eight Hours more after a ſecond Exhauſtion, and found one of them quite dead, but the other revived.

Frogs and *Toads* bear the Pump long, eſpecially the former. A large *Toad*, found in the Houſe, died irrecoverable in leſs than ſix Hours. Another *Toad* and *Frog* I put in together, and the *Toad* was ſeemingly dead in two Hours, but the *Frog* juſt alive. After they had remained their eleven Hours, and ſeemingly dead, the *Frog* recovered in the open Air, only weak, but the *Toad* was quite dead. The ſame *Frog* being put in again for twenty ſeven Hours, then quite died.

The Animalcules in *Pepper-water* remained in *Vacuo* twenty four

And not only Animals themſelves, but even Trees and Plants, and the whole vegetable Race, owe their Vegetation and Life to this uſeful Element; as will appear when I come to ſpeak of them, and is manifeſt from their Glory and Verdure in a free Air, and their becoming Pale and Sickly, and Languiſhing and Dying, when by any means excluded from it (*g*).

Thus uſeful, thus neceſſary, is the Air to the Life of the animated Creatures; and no leſs is it to the Motion and Conveyance of many of them. All the winged Tribes owe their Flight and Buoyancy (*h*) to it, as ſhall be ſhewn in proper Place: And even the watry Inhabitants themſelves cannot aſcend

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four Hours. And after they had been expoſed a Day or two to the open Air, I found ſome of them dead, ſome alive.

(*g*) That the Air is the principal Cauſe of the Vegetation of Plants, *Borelli* proves, in his excellent Book *De Mot. Animal.* Vol. 2. Prop. 181. And in the next Propoſition, he aſſureth, *In Plantis quoque peragi Aeris reſpirationem quandam imperfectam, a quâ earum vita pendet, & conſervatur.* But of this more when I come to ſurvey Vegetables.

Some Lettice-Seed being ſown upon ſome Earth in the open Air, and ſome of the ſame Seed, at the ſame Time, upon other Earth in a Glaſs-Receiver of the Pneumatick Engine, afterwards exhauſted of Air: The Seed expoſed to the Air, was grown up an Inch and half high within Eight Days; but that in the exhauſted Receiver not at all. And Air being again admitted into the ſame emptied Receiver, to ſee whether any of the Seed would then come up, it was found, that in the Space of one Week it was grewn up to the Height of two or three Inches. Vide Phil. Tranſ. No. 23. Lowth. Abridg. Vol. 2. p. 206.

(*h*) *In volucribus pulmones perforati aerem inſpiratum in totam ventris cavitatem admittunt. Hujus ratio, ut propter corporis truncum Aere repletum & quaſi extenſum, ipſa magis volatilia evadant, faciliuſque ab Aere externo, propter intimi penum, ſuſtententur. Equidem piſces, quò levius in aquis natent, in Abdomine veſicas Aere inflatas geſtant: pariter & volucres, propter corporis truncum Aere impletum & quaſi inflatum, nudo Aeri incumbentes, minus gravantur, proindeque levius & expeditius volant.* Willis de Anim. Brut. p. 1. c. 3.

(*i*) *Piſces,*

aſcend and deſcend into their Element, well without it (*i*).

But it would be tedious to deſcend too far into Particulars, to reckon up the many Benefits of this noble Appendage of our Globe in many uſeful Engines (*k*);

(*i*) *Fiſhes, by reaſon of the Bladder of Air within them, can ſuſtain, or keep themſelves in any Depth of Water: For the Air in that Bladder being more or leſs compreſſed, according to the Depth the Fiſh ſwims at, takes up more or leſs Space; and conſequently, the Body of the Fiſh, part of whoſe Bulk this Bladder is, is greater or leſs according to the ſeveral Depths, and yet retains the ſame Weight. Now the Rule* de Inſidentibus humido *is, That a Body, that is heavier than ſo much Water, as is equal in Quantity to the Bulk of it, will ſink, a Body that is lighter will ſwim; a Body of equal Weight will reſt in any Part of the Water. By this Rule, if the Fiſh, in the middle Region of the Water, be of equal Weight to the Water, that is, commenſurate to the Bulk of it, the Fiſh will reſt there, without any Tendency upwards or downwards: And if the Fiſh be deeper in the Water, the Bulk of the Fiſh becoming leſs by the Compreſſion of the Bladder, and yet retaining the ſame Weight, it will ſink, and reſt at the Bottom. And on the other Side, if the Fiſh be higher than the middle Region, the Air dilating it ſelf, and the Bulk of the Fiſh conſequently increaſing, but not the Weight, the Fiſh will riſe upwards and reſt at the Top of the Water. Perhaps, the Fiſh by ſome Action can emit Air out of its Bladder———, and, when not enough, take in Air,——— and then it will not be wondred, that there ſhould be always a fit Proportion of Air in all Fiſhes to ſerve their Uſe,* &c. Then follows a Method of Mr. *Boyle*'s to experiment the Truth of this. After which, in Mr. *Lowthorp*'s Abridgment, follow Mr. *Ray*'s Obſervations. *I think that——— hath hit upon the true Uſe of the Swimming-Bladders in Fiſhes. For, 1. It hath been obſerved, that if the Swimming-Bladder of any Fiſh be pricked or broken, ſuch a Fiſh ſinks preſently to the Bottom, and can neither ſupport or raiſe it ſelf up in the Water. 2. Flat Fiſhes, as Soles, Plaiſe,* &c. *which lie always groveling at the Bottom, have no Swimming-Bladders that ever I could find. 3. In moſt Fiſhes there is a manifeſt Chanel leading from the Gullet———to the ſaid Bladder, which, without doubt, ſerves for the conveying Air thereunto.———In the Coat of this Bladder is a maſculous Power to contract it when the Fiſh liſts.* See more very curious Obſervations relating to this Matter, of the late great Mr. *Ray*, as alſo of the curious anonymous Gentleman, in the ingenious Mr. *Lowthorp*'s Abridgment, before cited, *p.* 845. from *Philoſoph. Tranſ.* No. 114, 115.

(*k*) Among

gines (*k*); in many of the Functions and Operations of Nature (*l*) in the Conveyance of Sounds; and a Thouſand Things beſides. And I ſhall but juſt mention the admirable Uſe of our Atmoſphere in miniſtring to the enlightening of the World, by its

(*k*) Among the Engines in which the Air is uſeful, Pumps may be accounted not contemptible ones, and divers other Hydraulical Engines, which need not to be particulary inſiſted on. In theſe the Water was imagined to riſe by the Power of Suction, to avoid a *Vacuum*, and ſuch unintelligible Stuff; but the juſtly famous Mr. *Boyle* was the firſt that ſolved theſe Phænomena by the Weight of the Atmoſphere. His ingenious and curious Obſervations and Experiments relating hereto, may be ſeen in his little Tract, *Of the Cauſe of Attraction by Suction*, and divers other of his Tracts.

(*l*) It would be endleſs to ſpecify the Uſes of the Air in Nature's Operations: I ſhall therefore, for a Sample only, name its great Uſe to the World in conſerving animated Bodies, whether endowed with animal or vegetative Life, and its contrary Quality of diſſolving other Bodies; by which Means many Bodies that would prove Nuiſances to the World, are put out of the Way, by being reduced into their firſt Principles, (as we ſay,) and ſo embodied with the Earth again. Of its Faculty as a Menſtruum, or its Power to diſſolve Bodies; I may Inſtance in Cryſtal-Glaſſes, which, with long keeping, eſpecially if not uſed, will in Time be reduced to a Powder, as I have ſeen. So divers Minerals, Earths, Stones, Foſſil-Shells, Wood, &c. which from *Noah*'s Flood, at leaſt for many Ages, have lain under Ground, ſo ſecure from Corruption, that, on the contrary, they have been thereby made much the ſtronger, have in the open Air ſoon mouldred away. Of which laſt, Mr. *Boyle* gives an Inſtance (from the *Diſſertation de admirandis Hungar. Aquis*) of a great Oak, like a huge Beam, dug out of a Salt-Mine in *Tranſylvania*, *ſo hard, that it would not eaſily be wrought upon by Iron Tools, yet, being expoſed to the Air out of the Mine, it became ſo rotten that in four Days it was eaſy to be broken, and crumbled between one's Fingers.* Boyle's Suſpic. about ſome hidden Qualities in the Air, *p.* 28. So the Trees turned out of the Earth by the Breaches at *Weſt-Thurrock* and *Dagenham*, near me, although probably no other than *Alder*, and interred many Ages ago in a rotten oazy Mould, were ſo exceedingly tough, hard, and ſound at firſt, that I could make

its reflecting the Light of the heavenly Bodies to us (*m*); and refracting the Sun-beams to our Eye, before it ever ſurmounteth our Horizon (*n*); by which means the Day is protracted throughout the whole Globe; and the long and diſmal Nights are ſhorten'd in the frigid Zones, and Day ſooner approacheth

make but little Impreſſions on them with the Strokes of an Ax; but being expoſed to the Air and Water, ſoon became ſo rotten as to be crumbled between the Fingers. See my Obſervations in *Philoſ. Tranſact.* No. 335.

(*m*) *By reflecting the Light of the heavenly Bodies to us*, I mean that Whiteneſs or Lightneſs which is in the Air in the Day-Time, cauſed by the Rays of Light ſtriking upon the Particles of the Atmoſphere, as well as upon the Clouds above, and the other Objects beneath upon the Earth. To the ſame Cauſe alſo we owe the Twilight, *viz.* to the Sun-beams touching the uppermoſt Particles of our Atmoſphere, which they do when the Sun is about eighteen Degrees beneath the Horizon. And as the Beams reach more and more of the airy Particles, ſo Darkneſs goes off, and Daylight comes on and encreaſeth. For an Exemplification of this, the Experiment may ſerve of tranſmitting a few Rays of the Sun through a ſmall Hole into a dark Room: By which means the Rays which meet with Duſt, and other Particles flying in the Air, are render'd viſible; or (which amounts to the ſame) thoſe ſwimming ſmall Bodies are rendered viſible, by their reflecting the Light of the Sun-beams to the Eye, which, without ſuch Reflection, would it ſelf be inviſible.

The Azure Colour of the Sky Sir *Iſaac Newton* attributes to Vapours beginning to condenſe, and that are not able to reflect the other Colours. *V. Optic.* l. 2. *Par.* 3. *Prop.* 7.

(*n*) By the Refractive Power of the Air, the Sun, and the other heavenly Bodies ſeem higher than really they are, eſpecially near the Horizon. What the Refractions amount unto, what Variations they have, and what Alterations in time they cauſe, may be briefly ſeen in a little Book called, *The Artificial Clock-Maker*, Chap. 11.

Although this inflective Quality of the Air be a great Incumbrance and Confuſion of Aſtronomical Obſervations;——yet it is not without ſome conſiderable Benefit to Navigation; and indeed in ſome Caſes the Benefit thereby obtained is much greater than would be the Benefit of having the Ray proceed in an exact ſtraight Line. [Then he mentions

proacheth them; yea, the Sun it ſelf riſeth in Appearance (when really it is abſent from them) to the great Comfort of thoſe forlorn Places (*o*).

But paſſing by all theſe Things with only a bare mention, and wholly omitting others that might have been named, I ſhall only inſiſt upon the excellent Uſe of this noble circumambient Companion of our Globe, in reſpect of two of its Meteors, the Winds, and the Clouds and Rain (*p*).

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tions the Benefit hereof to the Polar Parts of the World.] *But this by the by,* (ſaith he.) *The great Advantage I conſider therein, is the firſt Diſcovery of Land upon the Sea; for by Means hereof, the Tops of Hills and Lands are raiſed up into the Air, ſo as to be diſcoverable ſeveral Leagues farther off on the Sea than they would be, were there no ſuch Refraction, which is of great Benefit to Navigation for ſteering their Courſe in the Night, when they approach near Land; and likewiſe for directing them in the Day-time, much more certainly than the moſt exact Celeſtial Obſervations could do by the Help of an uninflected Ray, eſpecially in ſuch Places as they have no Soundings.* [Then he propoſes a Method to find, by theſe Means, the Diſtance of Objects at Sea.] *Vide Dr.* Hook's *Poſt. Works, Lect. of Navig. p.* 466.

(*o*) *Cum Belgæ in novâ Zemblâ hybernarent, Sol illis apparuit* 16 *diebus citiùs, quàm revera in Horizonte exiſteret, hoc eſt, cùm adhuc infra Horizontem depreſſus eſſet quatuor circiter gradibus, & quidem aere ſereno.* Varen. Geog. c. 19. Prop. 22.

[Theſe Hollanders] *found, that the Night in that Place ſhortened no leſs than a whole Month; which muſt needs be a very great Comfort to all ſuch Places as live very far towards the North and South Poles, where Length of Night, and want of ſeeing the Sun, cannot chuſe but be very tedious and irkſome.* Hook Ibid.

[By Means of the Refractions] *we found the Sun to riſe twenty Minutes before it ſhould; and in the Evening to remain above the Horizon twenty Minutes* (or thereabouts) *longer than it ſhould.* Capt. *James*'s Journ. in *Boyle* of Cold. Tit. 18. p. 190.

(*p*) *Aer—in Nubes cogitur: humoremque colligens terram auget imbribus: tum effluens huc & illuc, ventos efficit. Idem annuas frigorum & calorum facit varietates: idemque & volatus Alitum ſuſtinet, & ſpiritu ductus alit & ſuſtentat animantes.* Cic. de Nat. Deor. l. 2. c. 39.

CHAP

CHAP. II. *Of the Winds* (a).

TO pass by other Considerations, whereby I might demonstrate the Winds to be the Infinite Creator's Contrivance, I shall insist only upon their great Usefulness to the World. And so great is their Use, and of such absolute Necessity are they to the Salubrity of the Atmosphere, that all the World would be poisoned without those Agitations thereof. We find how putrid, fetid, and unfit for Respiration, as well as Health and Pleasure, a stagnating,

(a) *Ventus est aer fluens*, is *Seneca*'s Definition. *Na. Qu. l.* 5. And as Wind is a Current of the Air, so that which excites or alters its Currents, may be justly said to be the Cause of the Winds. An Æquipoise of the Atmosphere produceth a Calm; but if that Æquipoise be more or less taken off, a Stream of Air, or Wind, is thereby accordingly produced either stronger or weaker, swifter or slower. And divers Things there are that may make such Alterations in the Æquipoise or Balance of the Atmosphere, *viz.* Eruptions of Vapours from Sea or Land; Rarefactions and Condensations in one Place more than another; the falling of Rain, pressure of the Clouds, &c. *Pliny* l. 2. c. 45. tells us of a certain *Cavern* in *Dalmatia*, called *Senta*, *in quem*, saith he, *dejecto levi pondere, quamvis tranquillo die, turbini similis emicat procella*. But as to Caves it is observed, that they often emit Winds more or less. Dr. *Conner*, taking notice of this Matter, specifies these, *In regno Neapolitano ex immani Cumanæ Sibyllæ antro tenuem ventum effluentem percepi*. The like he observed at the Caves at *Baiæ*, and in some of the Mines of *Germany*, and in the large Salt-Mines of *Cracow* in *Poland*. *Ubi*, saith he, *opifices & ipse fodinæ dominus Andreas Morstin, Nob. Polonus, mihi asseruerunt, quòd tanta aliquando Ventorum tempestas ex ambagiosis hujus fodinæ recessibus surgere solebat, quod laborantes fossores humi prosternebat, nec non portas & domicilia (quæ sibi in hâc fodinâ artifices exstruunt) penitùs evertebat*. Bern. Connor. Dissert. Med. Phys. p. 33. Artic. 3.

And as great Caves, so great Lakes sometimes send forth Winds. So *Gassendus* saith the *Lacus Legnius* doth, *E quo dum exoritur*

ſtagnating, confined, pent-up Air is. And if the whole Maſs of Air and Vapours was always at Reſt, and without Motion, inſtead of refreſhing and animating, it would ſuffocate and poiſon all the World.

But

exoritur fumus, nubes haud dubiè creanda eſt, qua ſit brevi in tempeſtatem ſæviſſimam exoneranda. Gaſſend. Vit. Peiresk. l. 5. p. 417.

But the moſt univerſal and conſtant Alterations of the Balance of the Atmoſphere, are from Heat and Cold. This is manifeſt in the General Trade-Winds, blowing all the Year between the Tropicks from Eaſt to Weſt: if the Cauſe thereof be (as ſome ingenious Men imagine) the Sun's daily Progreſs round that Part of the Globe, and by his Heat rarefying one Part of the Air, whilſt the cooler and heavier Air behind preſſeth after. So the Sea and Land Breezes in Note *d*. And ſo in our Climate, the Northerly and Southerly Winds (commonly eſteemed the Cauſes of cold and warm Weather,) are really the Effects of the Cold or Warmth of the Atmoſphere: Of which I have had ſo many Confirmations, that I have no Doubt of it. As for inſtance, it is not uncommon to ſee a warm Southerly Wind, ſuddenly changed to the North, by the fall of Snow or Hail; to ſee the Wind in a froſty, cold Morning North, and when the Sun hath well warmed the Earth and Air, you may obſerve it to wheel about towards the Southerly Quarters; and again to turn Northerly or Eaſterly in the cold Evening. It is from hence alſo, That in Thunder-Showers the Wind and Clouds are oftentimes contrary to one another, (eſpecially if Hail falls) the ſultry Weather below directing the Wind one way; and the Cold above the Clouds another way. I took Notice upon *March* the 10th, 1710-11, (and divers ſuch like Inſtances I have had before and ſince) that the Morning was warm, and what Wind ſtirred was Weſt-South-Weſt, but the Clouds were thick and black (as generally they are when Snow enſues:) A little before Noon the Wind veered about to North by Weſt, and ſometimes to other Points, the Clouds at the ſame time flying ſome North by Weſt, ſome South-Weſt: About One of the Clock it rained apace, the Clouds flying ſometimes North-Eaſt, then North, and at laſt both Wind and Clouds ſettled North by Weſt; at which time Sleet fell plentifully, and it grew very cold. From all which I obſerve, 1. That altho' our Region below was warm, the Region of the Clouds was cold, as the black, ſnowy Clouds ſhewed, 2. That the ſtruggle

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But the perpetual Commotions it receives from the Gales and Storms, keep it pure and healthful (*b*).

Neither are those Ventilations beneficial only to the Health, but to the Pleasure also of the Inhabitants of the Terraqueous Globe; witness the Gales which fan us in the Heat of Summer; without which, even in this our temperate Zone, Men are scarce able to perform the Labours of their Calling, or

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gle between the Warmth of ours, and the Cold of the cloudy Region, stopped the airy Currents of both Regions. 3. That the falling of the Snow through our warmer Air melted into Rain at first; but that it became Sleet after the superiour Cold had conquered the inferiour Warmth. 4. That, as that Cold prevailed by Degrees, so by Degrees it wheeled about both the Winds and Clouds from the Northwards towards the South.

Hippocrates, l. 2. *De Vict. Orat. Omnes Ventos vel à nive, glacie, vehementi gelu, fluminibus, &c. spirare necesse judicat.* Bartholin. de usu Nivis, c. 1.

(*b*) *It is well observed in my Lord* Howard's *Voyage to* Constantinople, *That at* Vienna *they have frequent Winds, which if they cease long in Summer, the Plague often ensues: So that it is now grown into a Proverb, That if* Austria *be not windy, it is subject to Contagion.* Bohun of Wind, p. 213.

From some such Commotions of the Air I imagine it is, that at *Grand-Cairo* the Plague immediately ceases, as soon as the *Nile* begins to overflow; although Mr. *Boyle* attributes it to nitrous Corpuscles. *Determ. Nat. of Effluv.* Chap. 4.

Nulla enim propemodum regio est, quæ non habeat aliquem flatum e se nascentem, & circa se cadentem.

Inter cætera itaque Providentiæ opera, hoc quoque aliquis, ut dignum admiratione suspexerit. Non enim ex unâ causâ Ventos aut invenit, aut per diversa disposuit: sed primum ut aera non sinerent pigrescere, sed assiduâ vexatione utilem redderent, vitalemque tracturis. Sen. Nat. Quæst. l. 5. c. 17, 18.

All this is more evident, from the Cause assigned to malignant epidemical Diseases, particularly the Plague, by my ingenious, learned Friend, Dr. *Mead*; and that is, an hot and moist Temperament of the Air, which is observed by *Hippocrates*, *Galen*, and the general Histories of Epidemical Diseases, to attend those Distempers. *Vide* Mead *of Poisons, Essay* 5. *p.* 161. But indeed, whether the Cause be this, or poisonous,

or not without Danger of Health and Life (*c*). But eſpecially, witneſs the perpetual Gales which throughout the whole Year do fan the Torrid Zone, and make that Climate an healthful and pleaſant Habi-

ous, malignant Exhalations or Animalcules, as others think, the Winds are however very ſalutiferous in ſuch Caſes, in cooling the Air, and diſperſing and driving away the moiſt or peſtiferous Vapours.

(*c*) *July* 8. 1707. (called for ſome time after the *Hot Tueſday*,) was ſo exceſſively hot and ſuffocating, by reaſon there was no Wind ſtirring, that divers Perſons died, or were in great Danger of Death, in their Harveſt-Work. Particularly one who had formerly been my Servant, a healthy, luſty, young Man, was killed by the Heat; and ſeveral Horſes on the Road dropped down and died the ſame Day.

In the foregoing Notes, having Notice of ſome Things relating to Heat, although it be ſomewhat out of the way, I hope the Reader will excuſe me, if I entertain him with ſome Obſervations I made about the Heat of the Air under the Line, compared with the Heat of our Bodies. *J. Patrick*, who, as he is very accurate in making Barometrical and Thermometrical Inſtruments, had the Curioſity for the nicer adjuſting his Thermometers, to ſend two abroad (under the Care of two very ſenſible ingenious Men) one to the Northern Lat. of 81; the other to the Parts under the Æquinoctial: In theſe two different Climates, the Places were marked where the Spirits ſtood at the ſevereſt Cold and greateſt Heat. And according to theſe Obſervations he graduates his Thermometers. With his Standard I compared my Standard Thermometer, from all the Degrees of Cold, I could make with *Sal Armoniack*, &c. to the greateſt Degrees of Heat our Thermometers would reach to. And with the ſame Thermometer (of mine) I experimented the greateſt Heat of my Body, in *July* 1709. Firſt in an hot Day without Exerciſe, by putting the Ball of my Thermometer under my Armpits, and other hotteſt parts of my Body. By which means the Spirits were raiſed 284 Tenths of an Inch above the Ball. After that, in a much hotter Day, and indeed nearly as hot as any Day with us, and after I had heated my ſelf with ſtrong Exerciſe too, as much as I could well bear, I again tried the ſame Experiment, but could not get the Spirits above 288 Tenths; which I thought an inconſiderable Difference, for ſo ſeemingly a very different Heat of my Body. But from ſome

Habitation, which would otherwiſe be ſcarce habitable.

To theſe I might add many other great Conveniencies of the Winds in various Engines, and various Buſineſſes. I might particularly inſiſt upon its great Uſe to tranſport Men to the fartheſt diſtant Regions of the World; (*d*) and I might particularly ſpeak of the general and coaſting Trade-Winds, the Sea, and the Land-Breezes; (*e*) the one ſerving to carry the Mariner in long Voyages from Eaſt to Weſt; the other ſerving to waft him to particular Places;

Experiments I have made (altho' I have unfortunately forgotten them) in very cold Weather, I imagine the Heat of an healthy Body to be always much the ſame in the warmeſt Parts thereof, both in Summer and Winter. Now between thoſe very Degrees of 284, and 288, the Point of the equatorial Heat falleth. From which Obſervation it appears, that there is pretty nearly an equal Contemperament of the Warmth of our Bodies, to that of the hotteſt Part of the Atmoſphere inhabited by us.

If the Proportion of the Degrees of Heat be deſired from the Freezing-Point, to the Winter, Spring, and Summer Air, the Heat of Man's Body, of heated Water, melted Metals, and ſo to actual Fire; an Account may be met with of it, by my moſt ingenious Friend, the great Sir *Iſaac Newton*, in *Phil. Tranſact.* No. 270.

(*d*) *In hoc* Providentia *ac* Diſpoſitor *ille Mundi* Deus, *aera ventis exercendum dedit,——non ut nos claſſes partem freti occupaturas compleremus milite armato, &c. Dedit ille ventos ad cuſtodiendam cœli terrarumque temperiem, ad evocandas ſupprimendaſque aquas, ad alendos ſatorum atque arborum fructus; quos ad maturitatem cum aliis cauſis adducit ipſa jactatio, attrahens cibum in ſumma, & ne torpeat, promovens. Dedit ventos ad ulteriora noſcenda: fuiſſet enim imperitum animal, & ſine magnâ experientiâ rerum Homo, ſi circumſcriberetur natalis ſoli fine. Dedit ventos ut commoda cujuſque regionis fierent communia; non ut legiones equitemque geſtarent, nec ut perniciosa gentibus arma tranſveherent.* Seneca, ibid.

(*e*) Sea-Breezes *commonly riſe in the Morning about Nine a Clock.——They firſt approach the Shore gently, as if they were afraid to come near it.——It comes in a fine, ſmall, black Curle upon the Water,*

Places; the one ſerving to carry him into his Harbour, the other to bring him out. But I ſhould go too far to take Notice of all Particulars (*f*). Leaving therefore the Winds, I proceed, in the next Place, to the Clouds and Rain.

Water, whereas all the Sea between it and the Shore (not yet reached by it) is as ſmooth and even as Glaſs in Compariſon. In half an Hours Time after it has reached the Shore, it fans pretty briskly, and ſo encreaſeth gradually till Twelve a Clock; then it is commonly the ſtrongeſt, and laſts ſo till Two or Three, a very brisk Gale.——After Three it begins to die away again, and gradually withdraws its Force till all is ſpent; and about Five a Clock——it is lulled aſleep, and comes no more till next Morning.

And as the Sea-Breezes do blow in the Day, and reſt in the Night; ſo on the contrary [The Land-Breezes] *blow in the Night, and reſt in the Day, alternately ſucceeding each other.——They ſpring up between Six and Twelve at Night, and laſt till Six, Eight, or Ten in the Morning.* Dampier's Diſc. of Winds, *ch.* 4.

(*f*) One Thing more I believe ſome of my Friends will expect from me is, That I ſhew the Reſult of comparing my own Obſervations of the Winds, with others they know I have from *Ireland*, *Switzerland*, *Italy*, *France*, *New-England*, and ſome of our Parts of *England*. But the Obſervations being, ſome of them, but of one Year, and moſt of the reſt of but a few Years, I have not been able to determine any great Matters. The Chief of what I have obſerved is, That the Winds in all theſe Places ſeldom agree; but when they moſt certainly do ſo, it is commonly when the Winds are ſtrong, and of long Continuance in the ſame Quarter: And more, I think, in the Northerly and Eaſterly, than other Points. Alſo, a ſtrong Wind in one Place, is oftentimes a weak one in another Place, or moderate, according as Places have been nearer or farther diſtant. *Vide Philoſoph. Tranſact.* No. 297, and 321. But to give a good and tolerable Account of this, or any other of the Weather, it is neceſſary to have good Hiſtories thereof from all Parts; which, as yet we have but few of, and they imperfect, for want of longer and ſufficient Obſervations.

CHAP. III. *Of the Clouds and Rain.*

THE Clouds and Rain (*a*) we ſhall find to be no leſs uſeful Meteors than the laſt mentioned; as is manifeſt in the refreſhing pleaſant Shades which the Clouds afford, and the fertile Dews and Showers which they pour down on the Trees and Plants, which would languiſh and die with

(*a*) Clouds and Rain are made of Vapours raiſed from Water, or Moiſture only. So that I utterly exclude the Notion of Dry, Terene Exhalations, or Fumes, talked much of by moſt Philoſophers; Fumes being really no other than the humid Parts of Bodies reſpectively Dry.

Theſe Vapours are demonſtratively no other than ſmall Bubbles, or Veſiculæ detached from the Waters by the Power of the Solar, or Subterraneous Heat, or both. Of which ſee *Book* 2. *Chap.* 5. *Note* (*b*). And being lighter than the Atmoſphere, are buoyed up thereby, until they become of an equal Weight therewith, in ſome of its Regions aloft in the Air, or nearer the Earth; in which thoſe Vapours are formed into Clouds, Rain, Snow, Hail, Lightning, Dew, Miſts, and other Meteors.

In this Formation of Meteors the grand Agent is Cold, which commonly, if not always, occupies the ſuperior Regions of the Air; as is manifeſt from thoſe Mountains which exalt their lofty Tops into the upper and middle Regions, and are always covered with Snow and Ice.

This Cold, if it approaches near the Earth, preſently precipitates the Vapours, either in *Dews*; or if the Vapours more copiouſly aſcend, and ſoon meet the Cold, they are then condenſed into *Miſling*, or elſe into Showers of *ſmall Rain*, falling in numerous, thick, ſmall Drops: But if thoſe Vapours are not only copious, but alſo as heavy as our lower Air it ſelf (by means their Bladders are thick and fuller of Water,) in this Caſe they become viſible, ſwim but a little Height above the Earth, and make what we call a *Miſt* or *Fog*. But if they are a Degree lighter, ſo as to mount higher, but not any great Height, as alſo meet not with Cold enough to condenſe them, nor Wind to diſſipate them, they then form an heavy,

with perpetual Drought, but are hereby made Verdant and Flouriſhing, Gay and Ornamental; ſo that (as

heavy, thick, *dark Sky*, laſting oftentimes for ſeveral Weeks without either Sun or Rain. And in this Caſe, I have ſcarce ever known it to Rain, till it hath been *firſt Fair, and then Foul.* And Mr. *Clarke*, (an ingenious Clergyman of *Norfolk*,) who in his Life-time, long before me, took notice of it, and kept a Regiſter of the Weather for Thirty Years, which his learned Granſon, Dr. *Samuel Clarke* put into my Hands, he, (I ſay) ſaith, he ſcarce ever obſerved the Rule to fail in all that Time; only he adds, *If the Wind be in ſome of the eaſterly Points.* But I have obſerved the ſame to happen, be the Wind where it will. And from what hath been ſaid, the Caſe is eaſily accounted for, *viz.* whilſt the Vapours remain in the ſame State, the Weather doth ſo too. And ſuch Weather is generally attended with moderate Warmth, and with little or no Wind to diſturb the Vapours, and an heavy Atmoſphere to ſupport them, the Barometer being commonly high then. But when the Cold approacheth, and by condenſing drives the Vapours into Clouds or Drops, then is way made for the Sun-beams, till the ſame Vapours, being by further Condenſation formed into Rain, fall down in Drops.

The Cold's approaching the Vapours, and conſequently the Alteration of ſuch dark Weather I have beforehand perceived, by ſome few ſmall Drops of Rain, Hail, or Snow, now and then falling, before any Alteration hath been in the Weather; which I take to be from the Cold meeting ſome of the ſtraggling Vapours, or the uppermoſt of them, and condenſing them into Drops, before it arrives unto, and exerts it ſelf upon the main Body of Vapours below.

I have more largely than ordinary inſiſted upon this part of the Weather, partly as being ſomewhat out of the way; but chiefly, becauſe it gives Light to many other *Phænomena* of the Weather. Particularly we may hence diſcover the Original of Clouds, Rain, Hail, and Snow; that they are Vapours carried aloft by the Gravity of the Air, which meeting together ſo as to make a Fog above, they thereby form a *Cloud.* If the Cold condenſeth them into Drops, they then fall in *Rain*, if the Cold be not intenſe enough to freeze them: But if the Cold freezeth them in the Clouds, or in their Fall through the Air, they then become *Hail* or *Snow.*

As to *Lightning*, and other enkindled Vapours, I need ſay little in this Place, and ſhall therefore only obſerve, that they

(as the Pſalmiſt ſaith, *Pſal.* lxv. 12, 13.) *The little Hills rejoice on every ſide, and the Valleys ſhout for Joy, they alſo ſing.* And

owe alſo their Riſe to Vapours; but ſuch Vapours as are detached from mineral Juices, or at leaſt that are mingled with them, and are Fired by Fermentation.

Another *Phanomenon* reſolvable from what hath been ſaid is, why a *cold*, is always a *wet* Summer, *viz.* becauſe the Vapours riſing plentifully then, are by the Cold ſoon collected into Rain. A remarkable Inſtance of this we had in the Summer of 1708, part of which, eſpecially about the *Solſtice*, was much colder then uſually. On *June* 12, it was ſo cold, that my Thermometer was near the Point of hoar Froſt, and in ſome Places I heard there was an hoar Froſt; and during all the cool Weather of that Month, we had frequent and large Rains, ſo that the whole Month's Rain amounted to above two Inches Depth, which is a large Quantity for *Upminſter*, even in the wetteſt Months. And not only with us at *Upminſter*, but in other Places, particularly at *Zurich* in *Switzerland*, they ſeem to have had as unſeaſonable Cold and Wet as we. *Fuit hic menſis——præter modum humidus, & magno quidem vegetabilibus hominibuſque damno. Multum computruit Fœnum*, &c. complains the Induſtrious and learned Dr. *J. J. Scheuchzer:* Of which, and other Particulars, I have given a larger Account in *Phil. Tranſ.* No. 321.

In which *Tranſaction* I have obſerved farther, that about the Equinoxes we (at *Upminſter* at leaſt) have oftentimes more Rain than at other Seaſons. The Reaſon of which is manifeſt from what hath been ſaid, *viz.* in Spring, when the Earth and Waters are looſed from the brumal Conſtipations, the Vapours ariſe in great Plenty: And the like they do in Autumn, when the Summer Heats, that both diſſipated them, and warmed the ſuperior Regions, are abated; and then the Cold of the ſuperior Regions meeting them, condenſeth them into Showers, more plentifully than at other Seaſons, when either the Vapours are fewer, or the Cold that is to condenſe them is leſs.

The manner how Vapours are precipitated by the Cold, or reduced into Drops, I conceive to be thus: Vapours being, as I ſaid, no other than Inflated *Veſiculæ* of Water; when they meet with a colder Air than what is contained in them, the contained Air is reduced into a leſs Space, and the watery Shell or Caſe rendered thicker by that means, ſo as to become heavier than the Air, by which they are buoyed up, and conſequently muſt needs fall down. Alſo many of thoſe

thickned

And if to these Uses, we should add the Origine of Fountains and Rivers, to Vapours and the Rains,

thickned *Vesiculæ* run into one, and so form Drops, greater or smaller, according to the Quantity of Vapours collected together.

As to the Rain of different Places, I have in some of our *Transactions* assigned the Quantities; particularly in the last cited *Transaction*, I have assigned these, *viz.* the Depth of the Rain one Year with another, in *English* Measure, if it was to stagnate on the Earth, would amount unto, at *Townly* in *Lancashire*, 42 Inches and a half; at *Upminster* in *Essex* 19 Inches and a quarter; at *Zurich* in *Switzerland* 32 Inches and a quarter; at *Pisa* in *Italy* 43 Inches and a quarter; at *Paris* in *France* 19 Inches; and at *Lisle* in *Flanders* 24 Inches.

It would be endless to reckon up the *bloody* and other *prodigious Rains* taken notice of by Historians, and other Authors, as præternatural and ominous Accidents; but if strictly pried into, will be found owing to natural Causes: Of which, for the Reader's Satisfaction, I will give an instance or two. A Bloody Rain was imagined to have fallen in *France*, which put the Country People into so great a Fright, that they left their Work in the Fields, and in great haste flew to the Neighbouring Houses. *Peirisc* (then in the Neighbourhood) strictly inquiring into the Cause, found it to be only red Drops coming from a sort of Butterfly that flew about in great Numbers at that Time, as he concluded from seeing such red Drops come from them; and because these Drops were laid, *Non supra ædificia, non in devexis lapidum superficiebus, uti debuerat contingere, si è cœlo sanguine pluisset; sed in subcavis potius & in foraminibus,——Accessit, quòd parietes iis tingebantur, non qui in mediis oppidis, sed qui agrorum vicini erant, neque secundùm partes elatiores, sed ad mediocrem solùm altitudinem, quantam volitare Papiliones solent.* Gassend. in vit. Peiresk, L. 2. p. 156.

So Dr. *Merret* saith also, *Pluvia Sanguinis quàm certissime constat esse tantùm Insectorum excrementa; Pluvia Tritici quàm nihil aliud esse quàm Hederæ bacciferæ grana à Sturnis devorata excretaque comparanti liquidissimè patet.* Pinax rerum, &c. p. 220.

The curious *Worm* tells of the raining of Brimstone, *Anno* 1646. *Maii* 16. *Hîc Hafniæ cùm ingenti pluviâ tota urbs, omnesque ita inundarentur plateæ, ut gressus hominum impediret, Sulphureoque odore aërem inficeret, dilapsis aliquantulum aquis, quibusdam in locis colligere licuit Sulphureum pulverem, cujus portionem servo, colore, odore, & aliis verum Sulphur ferentem.* Musæ. Worm. L. 1. c. 11. Sect. 1.

Rains, as ſome of the moſt eminent modern Philoſophers

Together with the Rain we might take notice of other Meteors, particularly *Snow*; which although an irkſome Gueſt, yet hath its great Uſes, if all be true that the famous *T. Bartholin* ſaith of it, who wrote a Book *de Nivis Uſu Medico*. In which he ſhews of what great Uſe Snow is in fructifying the Earth, preſerving from the Plague, curing Fevers, Colicks, Head-Aches, Tooth-Aches, Sore Eyes, Plurifies, (for which Uſe he ſaith his Country-Women of *Denmark* keep Snow-water gathered in *March*,) alſo in prolonging Life, (of which he inſtanceth in the *Alpine* Inhabitants, that live to a great Age,) and preſerving dead Bodies; Inſtances of which he gives in Perſons buried under the Snow in paſſing the *Alps*, which are found uncorrupted in the Summer, when the Snow is melted; which ſad Spectacle he himſelf was an Eye-Witneſs of. And at *Spitzberg* in *Greenland*, dead Bodies remain entire and uncorrupted for thirty Years. And laſtly, concerning ſuch as are ſo preſerv'd when ſlain, he ſaith they remain in the ſame Poſture and Figure: Of which he gives this odd Example. *Viſum id extra urbem noſtram* [Hafniam] *quum*, 11 *Feb.* 1659. *oppugnantes hoſtes repellerentur, magnâque ſtrage occumberent; alii enim rigidi iratum vultum oſtendebant, alii oculos elatos; alii ore diducto ringentes, alii brachiis extenſis Gladium minari, alii alio ſitu proſtrati jacebant.* Barthol. de uſu Niv. c. 12.

But although Snow be attended with the Effects here named, and others ſpecified by the learned *Bartholin*; yet this is not to be attributed to any peculiar Virtue in the Snow, but ſome other Cauſe. Thus when it is ſaid to *fructify the Earth*, it doth ſo by guarding the Corn or other Vegetables againſt the intenſer Cold of the Air, eſpecially the cold piercing Winds; which the Husbandmen obſerve to be the moſt injurious to their Corn of all Weathers. So for *Conſerving dead Bodies*, it doth it by conſtipating ſuch Bodies, and preventing all ſuch Fermentations or internal Conflicts of their Particles, as would produce Corruption.

Such an Example as the preceding is ſaid to have happened ſome Years ago at *Paris*, in digging in a Cellar for ſuppoſed hidden Treaſure; in which, after digging ſome Hours, the Maid going to call her Maſter, found them all in their digging Poſtures, but dead. This being noiſed abroad, brought in not only the People, but Magiſtrates alſo, who found them accordingly; *Ille qui ligone terram effoderat, & ſocius qui palâ effoſſam terram removerat, ambo pedibus ſtabant, quaſi ſuo quiſque operi affixus incubuiſſet; uxor unius quaſi ab opere defeſſa in ſcamno, ſolicito quodam vultu,*

ſophers (*b*) have done, we ſhould have another Inſtance of the great Uſe and Benefit of that Meteor.

And now, if we reflect upon this neceſſary Appendage of the Terraqueous Globe, the *Atmoſphere*; and conſider the abſolute Neceſſity thereof to many Uſes of our Globe, and its great Convenience to the whole: And in a Word, that it anſwereth all the Ends and Purpoſes that we can ſuppoſe there can be for ſuch an Appendage: Who can but own this to be the Contrivance, the Work of the Great Creator? Who would ever ſay or imagine ſuch a Body, ſo different from the Globe it ſerves, could be made by Chance, or be adapted ſo exactly to all thoſe fore-mentioned grand Ends, by any other Efficient than by the Power and Wiſdom of the Infinite GOD! Who

vultu, ſedebat, inclinato in palmam manûs genibus innitentis capite; puerulus laxatis braccis in margine excavatæ foveæ defixis in terram oculis alvum exonerabat; omnes in naturali ſitu, carneæ tanquam ſtatuæ viridi, apertis oculis & vultu vitam quaſi reſpirante, exanimes ſtabant. Dr. Bern. Connor, Diſſert. Med. Phyſ. *p.* 15.

The Doctor attributes all this to Cold; but I ſcarce think there could be Cold enough to do all this at *Paris*, and in a Cellar too. But his following Stories are not improbable, of Men and Cattle killed with Cold, that remained in the very ſame Poſture in which they died; of which he gives, from a *Spaniſh* Captain, this Inſtance, that happened two Years before, of a Soldier who unfortunately ſtraggled from his Company that were foraging, and was killed with the Cold, but was thought to have fallen into the Enemies Hands. But ſoon after their return to their Quarters, they ſaw their Comrade returning, ſitting on Horſeback, and coming to congratulate him, found him dead, and that he had been brought thither in the ſame Poſture on Horſeback, notwithſtanding the jolting of the Horſe. *Ib. p.* 18.

(*b*) Of this Opinion was my late moſt ingenious and learned Friend, Mr. *Ray*, whoſe Reaſons ſee in his *Phyſico-Theolog. Diſcourſes*, Diſc. 2. ch. 2. p. 89, &c. So alſo my no leſs learned and ingenious Friends, Dr. *Halley*, and the late Dr. *Hook*, many of the *French* Vertuoſo's alſo, and divers other very conſiderable Men before them, too many to be ſpecified here.

(*c*) *An*

Who would not rather, from ſo noble a Work, readily acknowledge the Workman, (*c*) and as eaſily conclude the Atmoſphere to be made by God, as an Inſtrument wrought by its Power, any Pneumatick Engine, to be contrived and made by Man!

(*c*) *An Polycletum quidem admirabimur propter partium Statuæ—— convenientiam ac proportionem? Naturam autem non modò non laudabimus, ſed omni etiam arte privabimus, quæ partium proportionem non ſolum extrinſecus more Statuariorum, ſed in profundo etiam ſervavit? Nonne & Polycletus ipſe Naturæ eſt imitator, in quibus ſaltem eam potuit imitari? Potuit autem in ſolis externis partibus in quibus artem conſideravit.* With much more to the like Purpoſe. *Galen. de Uſ. Part. l.* 17. *c.* 1.

CHAP. IV. *Of Light.*

THus much for the firſt Thing miniſtring to the Terraqueous Globe, the Atmoſphere and its Meteors; the next Appendage is *Light.* (*a*) Concerning which, I have in my Survey of the Heavens (*b*) ſhewed what admirable Contrivances the infinitely wiſe Creator hath for the

(*a*) It is not worth while to enumerate the Opinions of the *Ariſtotelians*, *Carteſians*, and others, about the Nature of Light, *Ariſtotle* making it a Quality; *Cartes* a Pulſion, or Motion of the Globules of the ſecond Element. *Vide Cartes Princip.* p. 3. Sect. 55, *&c.* But with the Moderns, I take *Light* to conſiſt of material Particles, propagated from the Sun, and other luminous Bodies, not inſtantaneouſly, but in Time, according to the Notes following in this Chapter. But not to inſiſt upon other Arguments for the Proof of it, our noble Founder hath proved the Materiality of Light and Heat, from actual Experiments on Silver, Copper, Tin, Lead, Spelter, Iron, Tutenage, and other Bodies, expoſed (both naked and cloſely ſhut up) to the Fire: All which were conſtantly found to receive an Increment of Weight. I wiſh he could have met with a favourable Seaſon to have tried his Experiments with the Sun-Beams as he intended. *Vide* Boyle's *Exp. to make Fire and Flame ponderable.*

(*b*) Aſtro-Theol. Book 7. (*c*) *And*

the affording this noble, glorious, and comfortable Benefit to other Globes, as well as ours; the Proviſion he hath made by Moons, as well as by the Sun, for the Communication of it.

And now let us briefly conſider the great Neceſſity and Uſe thereof to all our Animal World. And this we ſhall find to be little leſs than the very Life and Pleaſure of all thoſe Creatures. For what Benefit would Life be of, what Pleaſure, what Comfort would it be for us to live in perpetual Darkneſs? How could we provide our ſelves with Food and Neceſſaries? How could we go about the leaſt Buſineſs, correſpond with one another, or be of any Uſe in the World, or any Creatures be the ſame to us, without Light, and thoſe admirable Organs of the Body, which the Great *Creator* hath adapted to the Perception of that Great Benefit?

But now by the Help of this admirable, this firſt-made (*c*), becauſe moſt neceſſary, Creature of God; by this, I ſay, all the Animal World is enabled to go here and there, as their Occaſions call; they can tranſact their Buſineſs by Day, and refreſh and recruit themſelves by Night, with Reſt and Sleep. They can with Admiration and Pleaſure, behold the glorious Works of God; they can view the Glories of the Heavens, and ſee the Beauties of the flowry Fields, the gay Attire of the feathered Tribe, the exquiſite Garniture of many Quadrupeds, Inſects, and other Creatures; they can take in the delightſome Landskips of divers Countries and Places; they can with Admiration ſee the Great Creator's wonderful Art and Contrivance in the Parts of Animals

(*c*) *And God ſaid, Let there be Light, and there was Light.* Gen. 1. 3.

(*d*) It

mals and Vegetables: And, in a Word, behold, the Harmony of this lower World, and of the Globes above, and ſurvey God's exquiſite Workmanſhip in every Creature.

To all which I might add the Improvements which the Sagacity of Men hath made of this noble Creature of God, by the Refractions and Reflections of Glaſſes. But it would be endleſs to enumerate all its particular Uſes and Benefits to our World.

But before I leave this Point, there are two Things concerning Light, which will deſerve an eſpecial Remark; and that is, its ſwift and almoſt inſtantaneous Motion, and its vaſt Extenſion.

1. It is a very great Act of the Providence of God, that ſo great a Benefit as Light is, is not long in its Paſſage from Place to Place. For was the Motion thereof no ſwifter than the Motion of the ſwifteſt Bodies on Earth, ſuch as of a Bullet out of a great Gun; or even of a Sound (*d*) (which is the ſwifteſt Motion we have next Light,) in this Caſe Light

(*d*) It may not be ungrateful to the Curious, to take Notice of the Velocity of theſe two Things.

According to the Obſervations of *Merſennus*, a Bullet ſhot out of a great Gun, flies 92 Fathom in a Second of Time, (*Vide Merſen. Baliſt.*) which is equal to 589 *Engliſh* Feet and a half; and according to the Computation of Mr. *Huygens*, it would be 25 Years in paſſing from the Earth to the Sun. But according to my own Obſervations made with one of her late Majeſty's *Sakers*, and a very accurate Pendulum-Chronometer, a Bullet, at its firſt Diſcharge, flies 510 Yards in five half Seconds, which is a Mile in a little above 17 half Seconds. And allowing the Sun's Diſtance to be, as in the next Note, a Bullet would be 33 Years and a half in flying, with its utmoſt Velocity, to the Sun.

As to the Velocity of Sound, ſee *Book* 4. *Chap.* 3. *Note* 28. according to which Rate there mentioned, a Sound would be near 17 Years and a half in flying as far as the Diſtance is from the Earth to the Sun. Confer here the Experiments of the *Acad. del Ciment.* p. 142, &c.

(*e*) Mr.

Light would take up, in its Progreſs from the Sun to us, above thirty two Years, at the rate of the firſt; and above ſeventeen Years, at the rate of the latter Motion.

The Inconveniencies of which would be, its Energy and Vigour would be greatly cooled and abated; its Rays would be leſs penetrant; and Darkneſs would with greater Difficulty and much Sluggiſhneſs, be diſſipated, eſpecially by the fainter Lights of our ſublunary, luminous Bodies. But paſſing with ſuch prodigious Velocity, with nearly the inſtantaneous Swiftneſs of almoſt Two hundred thouſand *Engliſh* Miles in one Second of Time, (*e*) or (which is the ſame Thing) being but about ſeven or eight Minutes of an Hour in coming from the Sun to us, therefore with all Security and Speed, we receive the kindly Effects and Influences of that noble and uſeful Creature of God.

2. Another Thing of great Conſideration about Light is, its vaſt Expanſion, its almoſt incomprehenſible, and inconceivable Extenſion, which, as a late

(*e*) Mr. *Romer*'s ingenious Hypotheſis about the Velocity of Light, hath been eſtabliſhed by the *Royal Academy*, and in the *Obſervatory* for eight Years, as our *Phil. Tranſ.* No. 136. obſerve from the *Journ. des Scavans*; our moſt eminent Aſtronomers alſo in *England* admit it: But Dr. *Hook* thinks with Monſieur *Cartes*, the Motion of Light Inſtantaneous, *Hook Poſt. Works, pag.* 77. And this he endeavours to explain, *pag.* 130, &c.

What Mr. *Romer*'s Hypotheſis is, may be ſeen in the *Phil. Tranſact.* before-cited: As alſo in the before-commended Sir *Iſaac Newton*'s *Opticks*: *Light is propagated from luminous Bodies in time, and ſpends about ſeven or eight Minutes of an Hour in paſſing from the Sun to the Earth. This was firſt obſerved by* Romer, *and then by others, by means of the Eclipſes of the Satellites of* Jupiter. *For theſe Eclipſes, when the Earth is between the* Sun *and* Jupiter, *happen about ſeven or eight Minutes ſooner than they ought to do by the Tables; and when the* Earth *is beyond the* Sun, *they happen about ſeven or eight Minutes*

late ingenious Author (*f*) ſaith, "Is as boundleſs "and unlimited as the Univerſe it ſelf, or the Ex- "panſum of all material Beings: The Vaſtneſs of "which is ſo great, that it exceeds the Comprehen- "ſions of Man's Underſtanding. Inſomuch, that "very many have aſſerted it abſolutely Infinite, "and without any Limits or Bounds.

And that this noble Creature of God is of this Extent, (*g*) is manifeſt from our ſeeing ſome of the fartheſt diſtant Objects, the heavenly Bodies, ſome with

nutes later than they ought to do: The reaſon being, that the Light of the Satellites hath farther to go in the latter Caſe than in the former, by the Diameter of the Earth's Orbit. Newt. Opt. L. 2. Part 3. Prop. 11.

Now foraſmuch as the Diſtance between the Sun and the Earth (according to the Computations in my *Aſtro-Theology*, *B.* 1. *ch.* 3. *Note* 2.) is 86051398 *Engliſh* Miles; therefore, at the rate of 7 Minutes and half, or 450 Seconds, in paſſing from the Sun, Light will be found to fly above 191225 Miles in one Second of Time.

(*f*) Dr. *Hook*'s Poſthumous Works. Lect. of Light, *p.* 76.

(*g*) For the Proof of this vaſt Extent of Light, I ſhall take the Computation of the ſame great Man, *pag.* 77. *If*, ſaith he, *we conſider firſt the vaſt Diſtance between us and the Sun, which from the beſt and lateſt Obſervations in Aſtronomy, is judged to be about* 10000 *Diameters of the Earth, each of which is about* 7925 Engliſh *Miles*; *therefore the Sun's Diſtance is* 7925000 *Miles*; *and if we conſider, That, according to the Obſervations, which I publiſhed to prove the Motion of the Earth*, [which were Obſervations of the Parallax of ſome of the fix'd Stars in the Head of *Draco*, made in 1699,] *the whole Diameter of the Orb*, viz. 20000, *made the Subtenſe but of one Minute to one of the fix'd Stars, which cannot therefore be leſs diſtant than* 3438 *Diameters of this great Orb, and conſequently* 68760000 *Diameters of the Earth: And if this Star be one of the neareſt, and that the Stars that are of one Degree leſſer in Magnitude* (*I mean not of the Second Magnitude, becauſe there may be many Degrees between the firſt and ſecond*) *be as much farther*; *and another Sort yet ſmaller be three Times as far*; *and a fourth four Times as far, and ſo onward, poſſibly to ſome* 100 *Degrees of Magnitude, ſuch as may be diſcovered by longer and longer Teleſcopes, that they may be* 100 *Times as far*; *then certainly this material Expanſion, a Part of which we are, muſt be ſo great, that 'twill infinitely exceed our ſhallow Conception to imagine. Now, by what I laſt mentioned, it*

is

with our naked Eye, ſome with the Help of Optical Inſtruments, and others in all Probability farther and farther, with better and better Inſtruments: And had we Inſtruments of Power equivalent to the Extent of Light, the luminous Bodies of the utmoſt Parts of the Univerſe, would, for the ſame Reaſon, be viſible too.

Now as Light is of greateſt Uſe to impower us to ſee Objects at all, ſo the Extenſion thereof is no leſs uſeful to enable us to ſee Objects afar off. By which Means we are afforded a Ken of thoſe many glorious Works of the Infinite Creator, viſible in the Heavens, and can improve them to ſome of the nobleſt Sciences, and moſt excellent Uſes of our own Globe.

is evident, That Light extends it ſelf to the utmoſt imaginable Parts, and by the Help of Teleſcopes we collect the Rays, and make them ſenſible to the Eye, which are emitted from ſome of the almoſt inconceivably remote Objects, &c.——*Nor is it only the great Body of the Sun, or the vaſt Bodies of the fix'd Stars, that are thus able to diſperſe the Light through the vaſt Expanſum of the Univerſe; but the ſmalleſt Spark of a lucid Body muſt do the very ſame Thing, even the ſmalleſt Globule ſtruck from a Steel by a Flint,* &c.

CHAP. V. *Of Gravity.*

THE laſt Thing ſubſervient to our Globe, that I ſhall take Notice of, is *Gravity* (*a*); or, that Tendency which Bodies have to the Centre of the Earth. In

(*a*) That there is ſuch a Thing as *Gravity*, is manifeſt from its Effects here upon Earth; and that the Heavenly Bodies attract or gravitate to one another, when placed at due Diſtances, is made highly probable by Sir *Iſaac Newton*. This attractive or gravitating Power, I take to be congenial to Matter, and imprinted on all the Matter of the Univerſe by the Creator's *Fiat* at the Creation. What the *Cauſe* of it is, the *Newtonian Philoſophy* doth not pretend to determine for want of Phænomena, upon which Foundation it is that that Philoſophy

In my *Aſtro-Theology, Book 6. Ch. 2.* I have ſhewn of what abſolute Neceſſity, and what a noble

Philſophy is grounded, and not upon chimerical and uncertain Hypotheſes: But whatever the Cauſe is, that *Cauſe penetrates even to the Centres of the Sun and Planets, without any Diminution of its Virtue; and it acteth not according to the Superficies of Bodies (as Mechanical Cauſes do) but in Proportion to the Quantity of their ſolid Matter:* And laſtly, *It acteth all round it at immenſe Diſtances, decreaſing in duplicate Proportion to thoſe Diſtances*, as Sir *Iſaac Newton* ſaith, *Princip. pag.* ult. What uſeful Deductions, and what a rational Philoſophy, have been drawn from hence, may be ſeen in the ſame Book.

This Attraction, or Gravity, as its Force is in a certain proportion, ſo makes the Deſcent of Bodies to be at a certain rate. And was it not for the Reſiſtance of the Medium, all Bodies would deſcend to the Earth at the ſame rate; the lighteſt Down, as ſwiftly as the heavieſt Mineral: As is manifeſt in the *Air-Pump*, in which the lighteſt Feather, Duſt, *&c.* and a piece of Lead, drop down ſeemingly in the ſame Time from the Top to the bottom of a tall exhauſted Receiver.

The rate of the Deſcent of heavy Bodies, according to *Galileo*, Mr. *Huyghens*, and Dr. *Halley* (after them) is 16 Feet one Inch in one Second of Time; and in more Seconds, as the Squares of thoſe Times. But in ſome accurate Experiments made in St. *Paul's Dome*, *June* 9. 1710. at the Height of 22 Feet, the Deſcent was ſcarcely 14 Feet in the firſt Second. The Experiments were made in the Preſence of ſome very conſiderable Members of the Royal Society, by Mr. *Hawksbee*, their Operator, with glaſs, hollow Balls, ſome empty, ſome filled with Quick-ſilver, the Barometer at 29⅞, the Thermometer 60 Degrees above Freezing. The Weight of the Balls, their Diameters, and Time of the Deſcent is in this Table.

Balls filled with Quick-Silver.			Empty Balls.			
Weight.	Diameter.	Time.	Weight.	Diameter.		Time.
Grains.	Tenth Inch.	half Seconds.	Grains.	Inch.	Tenth.	half Seconds.
908	8	8	510	5	1	17
993	8	8 leſs.	642	5	2	16
866	8	8	599	5	1	16
747	7 & half	8 more.	515	5	nearly	16 & half.
808	7 & half	8	483	5	nearly	17
784	7 & half	8 more.	641	5	1 2	16

The Reaſon why the heavy, full Balls fell in half the Time of the hollow ones, was the Reſiſtance of the Air: Which Reſiſtance is very ingeniouſly and accurately aſſigned by Dr. *Wallis*, in *Philoſ. Tranſ.* No. 186. And the Cauſe of the Reſiſt and

noble Contrivance this of Gravity is, for keeping the ſeveral Globes of the Univerſe from ſhattering to Pieces, as they evidently muſt do in a little Time, by their ſwift Rotation round their own Axes (*b*). The Terraqueous Globe particularly, which circumvolves at the rate of above 1000 Miles an Hour (*c*), would

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ance of all Fluids, (as Sir *Iſaac Newton*, *Opt.* Q. 20.) is partly from the *Friction* of the Parts of the Fluid, partly from the *Inertia* thereof. The Reſiſtance a ſpherical Body meets with from Friction, is as the right Angle under the Diameter, and the Velocity of the moving Body: And the Reſiſtance from the *Vis Inertiæ*, is as the Square of that Product.

For a farther Account of the Properties [illegible] Proportions, &c. of Gravity, in the Fall or Projection [illegible] Bodies, I ſhall refer to the larger Accounts of *Galilæus*, *Torricellius*, *Huygens*, Sir *Iſaac Newton*, &c. or to the ſhorter Accounts of Dr. *Halley*, in *Philoſoph. Tranſ.* abridged by Mr. *Lowthorp*, Vol. I. p. 561. or Dr. *Clarke*, in his Notes on *Rohault*, *Phyſ.* 2. c. 28. *ſect.* 13, 16. And for the Reſiſtance of Fluids, I refer to Dr. *Wallis*, before-cited, and the *Act. Erudit. Lipſ. May* 1693, where there is a Way to find the Force of Mediums upon Bodies of different Figures.

(*b*) That the heavenly Bodies move round their own Axis, is, beyond all Doubt, manifeſt to our Eye, in ſome of them, from the Spots viſible on them. The Spots on the Sun (eaſily viſible with an ordinary Glaſs) do manifeſt him to revolve round his own Axis in about 25 Days and quarter. The Spots on *Jupiter* and *Mars* prove thoſe two Planets to revolve alſo from Eaſt to Weſt, as Dr. *Hook* diſcovered in 1664, and 1665. And *Venus* alſo (although near the ſtrong Rays of the Sun) hath, from ſome Spots, been diſcovered by Mr. *Caſſini*, in 1666, and 1667, to have a manifeſt Rotation, *Vide Lowthorp's Abridg.* Vol. I. p. 382, and 423, 425. And ſuch Uniformity hath the *Creator* obſerv'd in the Works of Nature, that what is obſervable in one, is generally to be found in all others of the ſame Kind. So that ſince 'tis manifeſt the Sun, and three of his Planets whirl round, it is very reaſonable to conclude all the reſt do ſo too; yea, every Globe of the Univerſe.

(*c*) The Earth's Circumference being 25031 Miles and half, (according to *Book* II. *Chap.* 2. *Note* (*a*.)) if we divide that into 24 Hours, we ſhall find the Motion of the Earth to be near 1043 Miles in an Hour. Which, by the by, is a far more reaſonable and leſs rapid Rate, than that of the Sun would

would by the centrifugal Force of that Motion, be soon dissipated and spirtled into the circumambient Space, was it not kept together by this noble Contrivance of the Creator, this natural inherent Power, namely, the Power of Attraction or Gravity.

And as by this Power our Globe is defended against Dissipation, so all its Parts are kept in their proper Place and Order. All material Things do naturally gravitate thereto, and unite themselves therewith, and so preserve its Bulk intire (*d*). And the fleeting Waters, the most unruly of all its Parts, do by this Means keep their constant Æquipoise in the Globe (*e*), and remain in *that Place which*, the Psalmist tells us, *God hath founded for them; a Bound he had set, which they might not pass; that they turn not again to cover the Earth*, Psal. civ. 8, 9. So, that even in a natural Way, by Virtue of this excellent Contrivance of the Creator, the Observation of the Psalmist is perpetually fulfilled, *Psal.* lxxxix. 9. *Thou rulest the raging of the Sea; when the Waves thereof arise, thou stillest them.*

To these, and an hundred other Uses of Gravity that I might have named, I shall only just mention another thing owing to it, and that is *Levity* (*f*) that

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be, if we suppose the Earth to stand still, and the Sun to move round the Earth. For according to the Proportions in Note (*e*), of the preceding Chapter, the Circumference of the *Magnus Orbis* is 5406862225 *English* Miles, which divided by 24 Hours, gives 22528364 Miles in an Hour. But what is this to the Rapidity of the fix'd Stars, if we suppose them, not the Earth, to move? Which is a good Argument for the Earth's Motion.

(*d*) *Nihil majus, quam quòd ita stabilis est Mundus, atque ita cohæret ad permanendum, ut nihil nè excogitari quidem possit aptius. Omnes enim partes ejus undique medium locum capessentes, nituntur æqualiter: maximè autem corpora inter se juncta permanent, cùm quodam quasi vinculo*

(*f*) that, whereby what we call light Bodies ſwim, a Thing no leſs uſeful to the World than its oppoſite, *Gravity*, is in many Reſpects, to divers Tribes of Animals, but particularly ſerviceable to the raiſing up of Vapours (*g*), and to their Conveyance about the World. And

vinculo circumdata colligantur: quod facit ea natura, quæ per omnem mundum omnia Mente, & Ratione conficiens, funditur, & ad medium rapit, & convertit extrema. Cic. de Nat. Deor. l. 2. c. 45.

(*e*) *Eâdem ratione Mare, cùm ſupra terram ſit, medium tamen terræ locum expetens, conglobatur undique æqualiter, neque redundat, unquam, neque effunditur.* Id. paulo poſt.

(*f*) That there is no ſuch Thing as *poſitive Levity*, but that Levity is only a leſs Gravity, is abundantly manifeſted by the acute *Seig. Alph. Borelli de Mot. à Grav. pend.* cap. 4. See alſo the Annotations of the learned and ingenious Dr. *Clark*, on *Rohaulti Phyſ.* p. 1. c. 16. Note 3. Alſo the Experiments of the *Acad. del Cimento*, p. 118, &c. Dr. *Wallis*'s *Diſcourſe of Gravity and Gravitation before the Royal Society*, Nov. 12. 1674. p. 28, &c.

(*g*) I have before in *Note* (*a*), *Chap.* 3. ſhewn what *Vapours* are, and how they are rais'd. That which I ſhall here note, is their Quantity: Concerning which, the before-commended Dr. *Halley* hath given us ſome curious Experiments in our *Philoſoph. Tranſ.* which may be met with together in Mr. *Lowthorp*'s *Abridg.* Vol. II. p. 108, and 126. Mr. *Sedileau* alſo at *Paris* obſerved it for near three Years. By all their Obſervations it appears, that in the Winter Months the Evaporations are leaſt, and greateſt in Summer, and moſt of all in windy Weather. And by *Monſieur Sedileau*'s Obſervations it appears, that what is raiſed in Vapours, exceeds that which falleth in Rain. In the ſeven laſt Months of the Year 1688, the Evaporations amounted to 22 Inches 5 Lines; but the Rain only to Inches 6 Lines one third: In 1689, the Evaporations were 32 Inches 10 Lines and half; but the Rain 18 Inches 1 Line: In 1690, the Evaporations 30 Inches 11 Lines; the Rain 21 Inches one third of a Line. *Vide Mem. de Math. Phyſ. Ann.* 1692. p. 25.

If it be demanded, What becomes of the Overplus of Exhalations that deſcend not in Rain? I anſwer, They are partly rumbled down and ſpent by the Winds, and partly deſcend in Dews, which amount to a greater Quantity than is commonly imagined. Dr. *Halley* found the Deſcent of Vapours in Dews ſo prodigious at St. *Helena*, that he makes no doubt to attribute the Origin of Fountains thereto. And I my ſelf have ſeen in a ſtill, cool Evening, large thick Clouds hanging, with-

And now from this tranſient View of no other than the Out-works, than the bare Appendages of the Terraqueous Globe, we have ſo manifeſt a Sample of the Wiſdom, Power, and Goodneſs of the Infinite Creator, that it is eaſy to imagine the whole Fabrick is of a Piece, the Work of at leaſt a Skilful Artiſt. A Man that ſhould meet with a Palace (*h*) beſet with pleaſant Gardens, adorned with ſtately Avenues, furniſhed with well-contrived Aqueducts, Caſcades, and all other Appendages conducing to Convenience or Pleaſure, would eaſily imagine, that proportionable Architecture and Magnificence were within: But we ſhould conclude the Man was out of his Wits that ſhould aſſert and plead, that all was the Work of Chance, or other than of ſome wiſe and skilful Hand. And ſo when we Survey the bare Out-works of this our Globe, when we ſee ſo vaſt a Body, accouter'd with ſo noble a Furniture of Air, Light, and Gravity; with every Thing, in ſhort, that is neceſſary to the Preſervation and Security of the Globe it ſelf, or that conduceth to the Life, Health, and Happineſs, to the Propagation and Increaſe of all the prodigious Variety of Creatures the Globe is ſtocked with; when we ſee nothing wanting, nothing redundant or frivolous, nothing botching or ill-made, but that every Thing, even in the very Appendages alone, exactly anſwereth all its Ends and Occaſions: What elſe can be concluded, but that all was made with manifeſt Deſign, and that all the whole Structure is the Work of ſome Intelligent Being; ſome Artiſt, of Power and Skill equivalent to ſuch a Work?

out any Motion in the Air, which in two or three Hours Time have been melted down by Degrees, by the cold of the Evening, ſo that not any the leaſt Remains of them have been left.

(*h*) See *Book* II. *Chap.* 3. *Note* (*c*).



BOOK II.

Of the Terraqueous Globe it ſelf in General.

IN the foregoing Book having diſpatch'd the Out-works, let us take a Survey of the Principal Fabrick, *viz.* the *Terraqueous Globe* it ſelf; a moſt ſtupendious Work in every Particular of it, which doth no leſs Aggrandize its Maker (*a*), than every curious, complete Work doth its Workman. Let us caſt our Eyes here and there, let us ranſack all the Globe, let us with the greateſt Accuracy inſpect every Part thereof, ſearch out the inmoſt Secrets of any of the Creatures; let us examine them with all our Gauges, meaſure them with our niceſt Rules, pry into them with our Microſcopes,

(*a*) *Licet——oculis quodammodo contemplari pulchritudinem earum rerum, quas Divinâ Providentiâ dicimus conſtitutas. Ac principio Terra univerſa cernatur, locata in mediâ mundi ſede, ſolida, & globoſa ——veſtita floribus, herbis, arboribus, frugibus. Quorum omnium incredibilis multitudo, inſatiabili varietate diſtinguitur. Adde huc Fontium gelidas perennitates, liquores perlucidos Amnium, Riparum veſtitus verdidiſſimos, Speluncarum concavas altitudines, Saxorum aſperitates, impendentium Montium altitudines, immenſitateſque Camporum: Adde etiam reconditas Auri——venas——Quæ verò, & quàm varia genera Beſtiarum? ——Qui Volucrum lapſus, atque cantus? Qui Pecudum pactus?——Quid de Hominum genere dicam? Qui quaſi cultores terræ conſtituti, &c.——Quæ ſi, ut animis, ſic oculis videri poſſemus, nemo cunctam intuens terram, de Divinâ Ratione dubitaret.* Cic. de Nat. Deor. l. 2. c. 39.

croſcopes, and moſt exquiſite Inſtruments (*b*), ſtill we find them to bear Teſtimony to their Infinite Workman; and that they exceed all human Skill ſo far, as that the moſt exquiſite Copies and Imitations of the beſt Artiſts, are no other than rude bungling Pieces to them. And ſo far are we from being able to eſpy any Defect or Fault in them, that the better we know them, the more we admire them; and the farther we ſee into them, the more exquiſite we find them to be.

And for a Demonſtration of this, I ſhall,

I. Take a general Proſpect of the Terraqueous Globe.

II. Survey its Particulars.

I. The Things which will fall under a general Proſpect of the Globe, will be its *Figure*, *Bulk*, *Motion*, *Place*, *Diſtribution* into Earth and Waters, and the great *Variety* of all Things upon it and in it.

(*b*) *I cannot here omit the Obſervations that have been made in theſe later Times, ſince we have had the Uſe and Improvement of the* Microſcope, *concerning the great Difference, which by the Help of that, doth appear betwixt* Natural *and* Artificial *Things. Whatever is Natural, doth by that appear adorned with all imaginable Elegance and Beauty.——Whereas the moſt curious Works of Art, the ſharpeſt, fineſt Needle, doth appear as a blunt, rough Bar of Iron, coming from the Furnace, or the Forge. The moſt accurate Engravings or Emboſſments ſeem ſuch rude, bungling, deformed Works, as if they had been done with a Mattock, or a Trowel. So vaſt a Difference is there betwixt the Skill of* Nature, *and the Rudeneſs and Imperfection of* Art. *Biſhop* Wilk. Nat. Rel. L. 1. Ch. 6.

CHAP.

CHAP. I.

Of the Figure of the Terraqueous Globe.

THIS I ſuppoſe I may take for granted to be Spherical, or nearly ſo (*a*). And this muſt be allowed to be the moſt commodious, apt Figure for a World on many Accounts; as it is moſt capacious, as its Surface is equi-diſtant from the Centre, not

(*a*) Although the Terraqueous Globe be of an orbicular Figure, yet it is not ſtrictly ſo, 1. On account of its Hills and Vallies. But theſe are inconſiderable to the Earth's Semi-diameter; for they are but as the Duſt upon a common Globe. But, 2. Our modern Aſtronomers aſſign a much greater Variation from a globous Form, namely, that of a prolate Sphæroid, making the Polar about 34 Miles ſhorter than the Equatorial Diameter. The Cauſe of which they make to be the centrifugal Force of the diurnal Rotation of the Globe.

This Figure they imagine is in *Jupiter*, his Polar being to his Equatorial Diameter, as 39 three fifths to 40 three fifths. But whether it be ſo or no, I confeſs I could never perceive, altho' I have often viewed that Planet through very good, and long Glaſſes, particularly a tolerable good one of 72 Feet in my Hands: And although by reaſon of cloudy Weather, and (at preſent) *Jupiter*'s Proximity to the Sun, I have not been of late able to take a review of that Planet; yet *Saturn* (ſo far as his Ring would permit,) and *Mars* appear perfectly round, through Mr. *Huygens*'s long Glaſs of 126 Feet, which by Will he bequeathed, with its whole Apparatus, to our R. S. by whoſe Favour it is now in my Hands. And moreover, I believe it difficult, next to impoſſible, to meaſure the two Diameters to a 40th Part, by reaſon of the ſmallneſs of *Jupiter*'s apparent Diameter, and by reaſon he is moving all the Time of meaſuring him.

As to what is alledged from lengthening the Pendulums of Clocks, to make them keep the ſame Time under the Equator, as they do in our Climes: I have ſhewn from the like Variations in the Air-Pump, that this may ariſe from the rarity of the Air there, more than here. *Vid. Phil. Tranſ.* No. 294. But if the Degrees of a Meridian grow larger, the more we go to-

not only of the Globe, but at leaſt (nearly) of Gravity and Motion too, and as ſome have thought, of the central Heat and Waters. But theſe, and divers other Things I ſhall paſs over, and inſiſt only upon two or three other Benefits of this globous Figure of the Earth and Waters.

1. This Figure is the moſt commodious in regard of Heat, and I may add of Light alſo in ſome meaſure. For by this means, thoſe two great Benefits are uniformally and equally imparted to the World: They come harmoniouſly and gradually on, and as gradually go off again. So that the daily and yearly Returns of Light and Darkneſs, Cold and Heat, Moiſt and Dry, are Regular and Workman-like, (we may ſay,) which they would not be, eſpecially the former, if the Maſs of Earth and Waters were (as

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wards the Line, (as Mr. *Caſſini* affirms they do, by an 800th Part in every Degree, in *Phil. Tranſ.* No. 278.) then there is great Reaſon to conclude in behalf of this Sphæroidal Form.

The natural Cauſe of this Sphericity of our Globe, is (according to Sir *Iſaac Newton*'s Principles) that *Attraction*, which the Infinite Creator hath ſtamp'd on all the Matter of the Univerſe, whereby all Bodies, and all the Parts of Bodies, mutually attract themſelves, and one another. By which means, as all the Parts of Bodies tend naturally to their Centre, ſo they all betake themſelves to a globous Figure, unleſs ſome other more prevalent Cauſe interpoſe. Thus Drops of Quick-ſilver put on a ſpherical Form, the Parts thereof ſtrongly attracting one another. So Drops of Water have the ſame Form, when falling in the Air; but are Hemiſpherical only when they lie on a hard Body, by reaſon their Gravity doth ſo far over-power their ſelf-attracting Power, as to take off one half of their Sphericity. This Figure is commonly attributed to the Preſſure of the circumambient Air: But that this can't be the Cauſe, is manifeſt from the Air-Pump; the Caſe being the very ſame in an exhauſted Receiver, as in the open Air, and not any the leaſt Alteration of the Figure that I could perceive, in all the Trials I have made.

(*b*) It

as ſome fancied (*b*) it) a large Plain; or as others, ke a large Hill in the midſt of the Ocean; or of multangular Figure; or ſuch like.

2. This Figure is admirably adapted to the commodious and equal Diſtribution of the Waters in the lobe. For ſince, by the Laws of Gravity, the Vaters will poſſeſs the loweſt Place; therefore, if e Maſs of the Earth was cubick, priſmatick, or y other angular Figure, it would follow, that one oo vaſt a Part) would be drowned; and another e too dry. But being thus orbicular, the Waters e equally and commodiouſly diſtributed here and ere, according as the Divine Providence ſaw moſt ; of which I ſhall take Notice by and by.

3. The orbicular Figure of our Globe, is far the oſt beneficial to the Winds and Motions of the tmoſphere. It is not to be doubted, if the Earth as of ſome other, or indeed any other Figure, but at the Currents of Air would be much retarded, if t wholly ſtopped. We find by Experience, what fluence large and high Mountains, Bays, Capes, d Head-lands have upon the Winds; how they p ſome, retard many, and divert and change ear the Shores) even the *general* and *conſtant Winds*

(*b*) It would be frivolous, as well as endleſs, to reckon up e various Opinions of the Ancients about the Figure of the erraqueous Globe; ſome of them may be ſeen in *Varen. ogr. l.* 1. *c.* 3. *init.* or *Fonſton's Thaumat. c.* 1. *Artic.* 3. But among the variety of Opinions, one of the principal was, That e viſible Horizon was the Bounds of the Earth, and the ean the Bounds of the Horizon, that the Heavens and Earth ove this Ocean, was the whole viſible Univerſe; and that beneath the Ocean was *Hades*, or the *inviſible World*. Hence, hen the Sun ſet, he was ſaid *tingere ſe Oceano*; and when any ent to *Hades*, they muſt firſt paſs the Ocean. Of this Opion were not only the ancient Poets, and others among the Heathens,

Winds (*c*), that blow round the Globe in the Torrid Zone. And therefore, ſince this is the Effect of ſuch little Excreſcences, which have but little Proportion to our Globe, what would be the Conſequences of much vaſter Angles, which would equal a Quarter, Tenth, or but an Hundredth Part of the Globe's Radius? Certainly theſe muſt be ſuch a Barricade, as would greatly annoy, or rather abſolutely ſtop the Currents of the Atmoſphere, and thereby deprive the World of thoſe ſalutiferous Gales that I have ſaid keep it ſweet and clean.

Thus the Figure of our Globe doth manifeſt it to be a Work of Contrivance, inaſmuch as it is of the moſt commodious Figure; and all others would be liable to great and evident Inconveniences.

Heathens, but ſome of the Chriſtian Fathers too, particularly *Lactantius*, St. *Auguſtine*, and others, who thought their Opinion was favoured by the Pſalmiſt, in *Pſalm* xxiv. 2. and cxxxvi. 6. See *Bp. Uſher's Anſ. to a Jeſ. Chall.* p. 366, &c.

(*c*) *Neither do theſe conſtant* Trade Winds *uſually blow near the Shore, but only on the Ocean, at leaſt* 30 *or* 40 *Leagues off at Sea clear from any Land; eſpecially on the Weſt Coaſt, or Side of any Continent: For indeed on the Eaſt Side, the Eaſterly Wind being the true Trade-Wind, blows almoſt home to the Shore, ſo near as to receive a Check from the Land-Wind.* Dampier's Winds, Ch. 1.

And not only the *general Trade-Winds*, but alſo the *conſtant coaſting Trade-Winds*, are in like manner affected by the Lands. Thus, for Inſtance, on the Coaſt of *Angola* and *Peru*. But this, ſaith the curious Captain *Dampier*, the Reader muſt take notice of, *That the Trade-Winds that blow on any Coaſt, except the North Coaſt of* Africa, *whether they are conſtant, and blow all the Year, or whether they are ſhifting Winds, do never blow right in on the Shore, nor right along Shore, but go ſlanting, making an acute Angle of about* 22 *Degrees. Therefore, as the Land tends more Eaſt or Weſt, from North or South on the Coaſt; ſo the Winds do alter accordingly.* Ibid. ch. 2.

CHAP.

CHAP. II.

Of the Bulk of the Terraqueous Globe.

THE next Thing remarkable in the Terraqueous Globe, is the prodigious Bulk thereof (*a*). A Maſs of above 260 Thouſand Billion of Miles ſolid Content. A Work too grand for any thing leſs than a God to make. To which in the next Place we may add,

(*a*) It is not difficult to make a pretty near Computation of the Bulk of the Terraqueous Globe, from thoſe accurate Obſervations of a Degree made by Mr. *Norwood* in *England*, and Mr. *Picart*, and Mr. *Caſſini* in *France*. Whoſe Meaſures do in a ſurprizing manner agree. But Mr. *Caſſini*'s ſeeming to be the moſt accurate, (as I have ſhewn in my *Aſtro-Theology*, B. 1. *Ch.* 1. *Note* (*a*.) I have there made uſe of his Determinations. According to which the Diameter of the Earth being 7967,72 *Engliſh* Miles, its Ambit will be 25031 Miles and half; and ſuppoſing it to be Spherical) its Surface will be 199444220 Miles; which being multiplied into one third of its Semidiameter, gives the ſolid Content, *viz*, 26485600000 Miles.

CHAP. III.

The Motions of the Terraqueous Globe.

THE Motions the Terraqueous Globe hath, are round its own Axis, and round its Fountain of Light and Heat, the Sun (*a*). That ſo vaſt a Body as the Earth and Waters ſhould be moved at all

(*a*) With the *Copernicans*, I take it here for granted, that the Diurnal and Annual Revolutions are the Motions of the Terraqueous Globe, not of the Sun, *&c.* but for the Proof thereof I ſhall refer the Reader to the Preface of my *Aſtro-Theology*, and B. 4. *Chap.* 3.

(*b*) *Every*

all (*b*), that it ſhould undergo two ſuch different Motions, as the Diurnal and Annual are, and that theſe Motions ſhould be ſo conſtant and regularly (*c*) performed for near 6000 Years, without any the leaſt Alteration ever heard of (except ſome Hours which we read of in *Joſh.* x. 12, 13. and in *Hezekiah*'s Time, which, if they cannot be accounted for ſome other way, do greatly encreaſe the Wonder (*d*); theſe Things, I ſay,) do manifeſtly argue

(*b*) *Every Thing that is moved, muſt of Neceſſity be moved by ſomething elſe; and that Thing is moved by ſomething that is moved either by another Thing, or not by another Thing. If it be moved by that which is moved by another, we muſt of Neceſſity come to ſome* prima Mover, *that is not moved by another. For it is impoſſible, that what moveth, and is moved by another, ſhould proceed* in Infinitum. Ariſtot. Phyſ. l. 8. c. 5.

Solum quod ſeipſum movet, quia nunquam deſeritur à ſe, nunquam ne moveri quidem deſinit: quinetiam cæteris quæ moventur, hic fons hoc principium eſt movendi. Principii autem nulla eſt origo: nam e principio oriuntur omnia; ipſum autem nullâ ex re aliâ naſci poteſt: nec enim eſſet id principium, quod gigneretur aliunde. Cicer. Tuſc. Queſt. l. 1. c. 23.

Cogitemus qui fieri poſſit, ut tanta magnitudo, ab aliquâ poſſit natura, tanto tempore circumferri? Ego igitur aſſero Deum cauſam eſſe, ne aliter poſſe fieri. Plato in Epinom.

(*c*) Among the Cauſes which *Cleanthes* is ſaid in *Tully* to aſſign for Men's Belief of a Deity, one of the chief is, *Æquabilitatem motûs, converſionem Cœli, Solis, Lunæ, Siderumque omnium diſtinctionem, varietatem, pulchritudinem, ordinem: quarum rerum aſpectus ipſe ſatis indicaret, non eſſe ea fortuita. Ut ſiquis in domum aliquam, aut in gymnaſium, aut in forum venerit; cùm videat omnium rerum rationem, modum, diſciplinam, non poſſit ea ſine causâ fieri judicare, ſed eſſe aliquem intelligat, qui præſit, & cui pareatur: multo magis in tantis motibus, tantiſque viciſſitudinibus, tam multarum rerum atque tantarum ordinibus, in quibus nihil unquam immenſa & infinita vetuſtas mentita ſit, ſtatuat neceſſe eſt ab aliquâ Mente tantos naturæ motus gubernari.* Cic. de Nat. Deor. l. 2. c. 5.

Homines cœperunt Deum agnoſcere, cùm viderent Stellas, tantam concinnitatem efficere; ac dies, noctesque, æſtate, & hyeme, ſuos ſervare ſtatos ortus, atque obitus. Plutarch de placit. l. 1. c. 6.

(*d*) We need not be ſolicitous to elude the Hiſtory of theſe Miracles

rgue ſome Divine Infinite Power to be concerned herein (*e*): But eſpecially, if to all this we add the wonderful Convenience, yea abſolute Neceſſity of theſe Circumvolutions to the Inhabitants, yea all the Products of the Earth and Waters. For to one of theſe we owe the comfortable Changes of Day and Night; the one for Buſineſs, the other for Repoſe; (*f*) the one for Man, and moſt other Animals to gather and provide Food, Habitation, and other

iracles, as if they were only poetical Strains, as *Maimonides*, d ſome others fancy *Joſhuah*'s Day to have been, *viz.* only ordinary Summer's-Day; but ſuch as had the Work of many ys done in it; and therefore by a poetical Stretch made, if the Day had been lengthened by the Sun ſtanding ſtill. t in the Hiſtory they are ſeriouſly related, as real Matters Fact, and with ſuch Circumſtances as manifeſt them to have en miraculous Works of the Almighty: And the Prophet *bakkuk*, iii. 11. mentions that of *Joſhua* as ſuch. And there-e taking them to be miraculous Perverſions of the Courſe Nature, inſtead of being Objections, they are great Argu-nts of the Power of God: For in *Hezekiah*'s Caſe, to wheel Earth it ſelf backward, or by ſome extraordinary Refra-ons, to bring the Sun's Shadow backward 10 Degrees: Or *Joſhua*'s Caſe, to ſtop the diurnal Courſe of the Globe for ne Hours, and then again give it the ſame Motion; to do, ay, theſe Things, required the ſame Infinite Power which firſt gave the Terraqueous Globe its Motions.

(*e*) *Nam cùm diſpoſiti queſiſſem fœdera Mundi,*
Præſcriptoſque Maris fines, Annique meatus,
Et Lucis, Noctiſque vices: tunc omnia rebar
Conſilio firmata Dei, qui lege moveri
Sidera, qui fruges diverſo tempore naſci,
Qui variam Phœben alieno juſſerit igne
Compleri, Solemque ſuo; porrexerit undis
Littora; Tellurem medio libraverat axe.
Claudian in Rufin. L. 1. initio.

(*f*) *Diei noctiſque viciſſitudo conſervat animantes, tribuens aliud agendi tempus, aliud quieſcendi. Sic undique omni ratione concluditur, Mente, Conſilioque divino omnia in hoc mundo ad ſalutem omnium, conſervationemque admirabiliter adminiſtrari.* Cicer. de Nat. Deor. l. 2. c. 53.

(*g*) The

other Neceſſaries of Life; the other to reſt, refreſh, and recruit their Spirits (*g*), waſted with the Labours of the Day. To the other of thoſe Motions we owe the Seaſons of Summer and Winter, Spring and Autumn, together with the beneficial Inſtances and Effects which theſe have on the Bodies and State of Animals, Vegetables, and all other Things, both in the Tortid, Temperate, and Frigid Zones.

(*g*) The acute Dr. *Cheyne*, in his ingenious *Philoſ. Princ. of Natural Religion*, among other Uſes of Day and Night, ſaith, the Night is moſt proper for Sleep; becauſe when the Sun is above the Horizon, Sleep is prejudicial, by reaſon the Perſpirations are then too great. Alſo that Nutrition is moſtly, if not altogether, performed in Time of Reſt; the Blood having too quick a Motion in the Day; For which Reaſon, weak Perſons, Children, &c. are nouriſhed moſt, and recruit beſt by Sleep.

CHAP. IV.

Of the Place and Situation of the Terraqueous Globe, in reſpect of the Heavenly Bodies.

ANother Thing very conſiderable in our Globe, is its Place and Situation at a due Diſtance from the Sun (*a*), its Fountain of Light and Heat; and from its neighbouring Planets of the ſolar Syſtem,

(*a*) It is a manifeſt Sign of the Creator's Management and Care, in placing the Terraqueous Globe, at that very Diſtance it is from the Sun, and contempering our own Bodies, and all other Things, ſo duly to that Diſtance. For was the Earth farther from the Sun, the World would be ſtarved and frozen with Cold: And was it nigher we ſhould be burnt, at leaſt the moſt combuſtible Things would be ſo, and the World would be vexed with perpetual Conflagrations. For we ſee that a few of the Rays of the Sun, even no more than what fall within the Compaſs of half an Inch or an Inch in a Burning-Glaſs, will fire combuſtible Bodies, even in our own Climate.

(*b*) *Aſtro-*

ſtem, and from the fixt Stars. But theſe Things I have ſpoken more largely of in my *Survey of the Heavens* (*b*), and therefore only barely mention them now; to inſiſt more largely upon,

(*b*) *Aſtro-Theology*, Book vii. Chap. 7.

CHAP. V.

The Diſtribution of the Earth and Waters.

THE Diſtribution of the Waters and the dry Land, although it may ſeem rude and undeſigned to a careleſs View, and is by ſome taxed as ſuch (*a*), yet is admirably well adjuſted to the Uſes and Conveniences of our World. For

(*a*) The moſt eminent Author I have met with, that finds fault with the Diſtribution of the Earth and Waters, and indeed with the whole preſent Structure of the Globe, is the learned and eloquent Theoriſt, Dr. *Burnet*, who frequently exclaims on this Point: *Tellus noſtra, ſi totam ſimul complectamur, non eſt ordinata & venuſta rerum compages—ſed moles aggeſta varie, incertoque ſitu partium, nullâ ordinis aut venuſtatis habitâ ratione.* Theor. Sacr. l. 1. c. 7. *Ecquis autem à Deo hæc ita facta? &c.* ib. *Quo autem Herculeo labore opus eſſet ad excavandam terram in tantum hiatum?—Si immediatè à cauſâ primâ effectus ſuiſſet hic alveus, aliquem ſaltem ordinem, menſuram, & proportionem notare voluiſſet in ipſius formâ, & partium diſpoſitione;—ſed confuſa omnia, &c.* ib. c. 8. *Tellus noſtra cùm exigua ſit; eſt etiam rudis: Et in illâ exiguitate multa ſunt ſuperflua, multa inelegantia. Dimidiam terræ ſuperficiem emendat Oceanus; magnâ ex parte, ut mihi videtur, inutilis.* And then he goes on to ſhew how this Part of the Creation might be mended, *ib.* c. 10. All this is to me ſurprizing from an Author of great Ingenuity, who ſeems in his Book to have a juſt Opinion of, and due Veneration for God. But certainly ſuch Notions are very inconſiſtent with the Belief of God's creating, eſpecially his governing and ordering the World. But ſuppoſe the Terraqueous Globe was ſuch a rude, confuſed, inconvenient Maſs, as he pretends, yet it is well enough for a ſinful World. But beſides, what others have long ago abundantly anſwered, the following Survey, will, I hope, ſufficiently

For in the first Place, the Distribution is so well made, the Earth and Waters so handsomely, so Workman-like laid, every where all the World over, that there is a just æquipoise of the whole Globe. The *Northern* balanceth the *Southern Ocean*, the *Atlantick* the *Pacifick Sea*. The *American dry Land*, is a Counterpoise to the *European*, *Asiatick* and *African*.

In the next Place, the Earth and the Waters are so admirably well placed about in the Globe, as to be helpful to one another, to minister to one another's Uses. The great Oceans, and the lesser Seas and Lakes, are so admirably well distributed throughout the Globe (*b*), as to afford sufficient Vapours (*c*) for Clouds

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ently manifest it to be the Work of a Wise and Beneficent, as well as Omnipotent Creator.

(*b*) Some have objected against the Distribution of the Earth and Waters, as if the Waters occupied too large a Part of the Globe, which they think would be of greater Use, if it were dry Land. But then they do not consider that this would deprive the World of a due Quantity of Vapours and Rain. For if the Cavities, which contain the Sea, and other Waters, were deeper, although the Waters were no less in Quantity, only their Surfaces narrower and lesser, the Evaporations would be so much the less, inasmuch as those Evaporations are made from the Surface, and are, consequently, in Proportion to the Surface, not the Depth or Quantity of Water.

(*c*) I took notice before in *Book* I. *Chap.* 3. *Note* (*a*). That the Vapours constituting Clouds and Rain, are *Vesiculæ* of Water detached by Heat. The manner of which I conceive to be thus; Heat being of an agile Nature, or the lightest of all Bodies, easily breaks loose from them; and if they are humid in its Passage, carries along with it Particles, or little Cases of the Water; which being lighter than Air, are buoyed up thereby, and swim in it; until by knocking against one another, or being thickened by the Cold, (as in the Note before cited,) they are reduced into Clouds and Drops.

Having mentioned the manner how Vapours are raised, and there being more Room here than in the Note before-cited, I shall

Clouds and Rains, to temperate the Cold (c) of the Northern frozen Air, to cool and mitigate the Heats

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ſhall, for the Illuſtration of Nature's Proceſs, take notice of three Things obſervable to our Purpoſe, in Water over the Fire. 1. That the Evaporations are proportional to the Heat aſcending out of the Water. A ſmall Heat throws off but few Vapours, ſcarce viſible: A greater Heat, and aſcending in greater Quantities, carries off grnſſer, larger, and more numerous *Veſiculæ*, which we call a *Steam*: And if the Heat breaks through the Water with ſuch a Fury, as to lacerate and lift up great Quantities or Bubbles of Water, too heavy for the Air to carry or buoy up, it cauſeth what we call *Boyling*. And the Particles of Water thus mounted up by the Heat, are viſible Sphærules of Water, if viewed with a Microſcope, as they ſwim about in a Ray of the Sun let into a dark Room, with warm Water underneath; where ſome of the Vapours appear large, ſome ſmaller Sphærules, according (no doubt) to the larger and leſſer Quantities of Heat blowing them up and carrying them off. 2. If theſe Vapours be intercepted in their Aſcent by any Context, eſpecially cold Body, as Glaſs, Marble, &c. they are thereby reduced into Drops, and Maſſes of Water, like thoſe of Rain, &c. 3. Theſe Vapours in their Aſcent from the Water, may be obſerved, in cold froſty Weather, either to riſe but a little above the Water, and there to hang, or to glide on a little above its Surface: Or if the Weather be very cold, after a little Aſcent, they may be ſeen to fall back again into the Water; in their Aſcent and Deſcent deſcribing a Curve ſomewhat like that of an Arrow from a Bow. But in a warmer Air, and ſtill, the Vapours aſcend more nimbly and copiouſly, mounting up aloft, till they are out of Sight. But if the Air be warm and windy too, the Vapours are ſooner carried out of Sight, and make way for others. And accordingly I have often obſerved, that hot Liquors, if not ſet too thin, and not frequently ſtirred, cool lower in the greateſt Froſts, than in temperate Weather, eſpecially if windy. And it is manifeſt by good Experiments, that the Evaporations are leſs at thoſe Times than theſe; leſs by far in the Winter than the warmer Months.

(c) As our Northern Iſlands are obſerved to be more temperate than our Continents, (of which we had a notable Inſtance in the great Froſt in 170$\frac{8}{9}$, which *Ireland* and *Scotland* felt leſs of, than moſt Parts of *Europe* beſides; of which ſee *Book* IV. *Chap.* 12. *Note* (c.) ſo this Temperature is owing to

Heats (*d*) of the Torrid Zone, and to refresh the Earth with fertile Showers; yea, in some Measure to minister fresh Waters to the Fountains and Rivers. Nay, so abundant is this great Blessing, which the most Indulgent Creator hath afforded us by Means of this Distribution of the Waters I am speaking of, that there is more than a scanty, bare Provision, or mere Sufficiency; even a Plenty, a Surplusage of this useful Creature of God, (the fresh Waters) afforded to the World; and they so well ordered, as not to drown the Nations of the Earth, nor to stagnate, stink, and poison, or annoy them; but to be gently carried through convenient Channels back again to their

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the warm Vapours afforded chiefly by the Sea, which by the preceding Note must necessarily be warm, as they are Vapours, or Water inflated by Heat.

The Cause of this Heat I take to be partly that of the Sun, and partly Subterraneous. That it is not wholly that of the Sun, is manifest from Vapours, being as, or more copiously raised when the Sun-Beams are weakest, as when strongest, there being greater Rains and Winds at the one Time than the other. And that there is such a Thing as *Subterraneous Heat*, (whether Central, or from the Meeting of Mineral Juices; or such as is Congenial or Connatural to our Globe, I have not Time to enquire; but I say that such a Thing is) is evident not only from the Hot-Baths, many fiery Erruptions and Explosions, *&c.* but also from the ordinary Warmth of Cellars and Places under Ground, which are not barely comparatively warm, but of sufficient Heat to raise Vapours also: As is manifest from the smoking of perennial Fountains in frosty Weather, and Water drawn out of Pumps and open Wells at such a Time. Yea, even Animals themselves are sensible of it, as particularly *Moles*, who dig before a Thaw, and against some other Alterations of the Weather; excited, no doubt, thereunto by the same warm Vapours arising in the Earth, which animate them, as well as produce the succeeding Changes of the Weather.

(*d*) Besides the *Trade-Winds*, which serve to mitigate the excessive Heats in the Torrid Zone; the Clouds are a good Screen against the scorching Sun-Beams, especially when the Sun passeth

their grand Fountain (*e*) the Sea; and many of them through ſuch large Tracts of Land, and to ſuch prodigious Diſtances, that it is a great Wonder the Foun-

paſſeth their Zenith; at which Time is their Winter, or cooleſt Seaſon, by Reaſon they have then moſt Clouds and Rain. For which Service, that which *Varene* takes Notice of, is a great Providence of God, *viz.* *Pleraque loca Zonæ Torridæ vicinum habent mare, ut India, Inſulæ Indicæ, Lingua Africæ, Guinea, Braſilia, Peruvia, Mexicana, Hiſpania: Pauca loca Zonæ Torridæ ſunt Mediterranea.* Varenii Geogr. l. 2. c. 26. Prop. 10. ſect. 7.

(*e*) That Springs have their Origin from the Sea, and not from Rains and Vapours, among many other ſtrong Reaſons, I conclude from the Perennity of divers Springs, which always afford the ſame Quantity of Water. Of this Sort there are many to be found every where. But I ſhall for an Inſtance, ſingle out one in the Pariſh of *Upminſter*, where I live, as being very proper for my Purpoſe, and one that I have had better Opportunities of making Remarks upon above twenty Years. This in the greateſt Droughts is little, if at all diminiſhed, that I could perceive by my Eye, although the Ponds all over the Country, and an adjoining Brook have been dry for many Months together; as particularly in the dry Summer Months of the Year 1705. And in the wetteſt Seaſons, ſuch as the Summer and other Months were, preceding the violent Storm in *November* 1703. (*Vid. Philoſ. Tranſ.* No. 289.) I ſay, in ſuch wet Seaſons I have not obſerved any Increment of its Stream, excepting only for violent Rains falling therein, or running down from the higher Land into it; which diſcoloureth the Waters oftentimes, and makes an increaſe of only a Day's, or ſometimes but a few Hours Continuance. But now, if this Spring had its Origin from Rain and Vapours, there would be an increaſe and decreaſe of the one, as there ſhould happen to be of the other: As actually it is in ſuch temporary Springs as have undoubtedly their Source from Rain and Vapours.

But beſides this, another conſiderable Thing in this *Upminſter* Spring (and Thouſands of others) is, that it breaks out of ſo inconſiderable an Hillock, or Eminence of Ground, that can have no more Influence in the Condenſation of the Vapours, or ſtopping the Clouds, (which the Maintainers of this Hypotheſis ſuppoſe) than the lower Lands about it have. By ſome Critical Obſervations I made with a very nice portable Barometer, I found that my Houſe ſtands between 80 and 90 Feet higher than the Low-Water Mark in the River of

Thames, neareſt me; and that Part of the River being ſcarce thirty Miles from the Sea, I gueſs, (and am more confirmed from ſome later Experiments I made nearer the Sea) that we cannot be much above 100 Feet above the Sea. The Spring I judge nearly level with, or but little higher than where my Houſe ſtands; and the Lands from whence it immediately iſſues, I gueſs about 15 or 20 Feet higher than the Spring; and the Lands above that, of no very remarkable Height. And indeed, by actual Meaſure, one of the higheſt Hills I have met with in *Eſſex*, is but 363 Feet high; *Vid. Phil. Tranſ.* No. 313. *p.* 16.) and I gueſs by ſome very late Experiments I made, neither that, nor any other Land in *Eſſex*, to be above 400 Feet above the Sea. Now what is ſo inconſiderable a Riſe of Land to a perennial Condenſation of Vapours, fit to maintain even ſo inconſiderable a Fountain, as what I have mentioned is? Or indeed the Highlands of the whole large County of *Eſſex*, to the maintaining of all its Fountains and Rivulets?

But I ſhall no farther proſecute this Argument, but refer to the late learned, curious and induſtrious Dr. *Plot*'s *Tentamen Phil. de Orig. Font.* in which he hath fully diſcuſſed this Matter.

As to the Manner how the Waters are raiſed up into the Mountains and higher Lands, an eaſy and natural Repreſentation may be made of it, by putting a little Heap of Sand, Aſhes, or a little Loaf of Bread, *&c.* in a Baſon of Water; where the Sand will repreſent the dry Land, or an Iſland, and the Baſon of Water the Sea about it. And as the Water in the Baſon riſeth to, or near the Top of the Heap in it, ſo doth the Waters of the Sea, Lakes, *&c.* riſe in the Hills. Which Caſe I take to be the ſame with the Aſcent of Liquids in Capillary Tubes, or between contiguous Planes, or in a Tube filled with Aſhes: Of which the induſtrious and compleat Artificer in Air-Pumps, Mr. *Hawksbee*, hath given us ſome, not contemptible Experiments, in his *Phyſ. Mech. Exp. p.* 139.

Among the many Cauſes aſſigned for this Aſcent of Liquors, there are two that bid the faireſt for it, *viz. the Preſſure of the Atmoſphere*, and the *Newtonian Attraction*. That it is not the former, appears from the Experiments ſucceeding, as well, or better in *Vacuo*, than in the open Air, the Aſcent being rather ſwifter in *Vacuo*. This then being not the Cauſe, I ſhall ſuppoſe the other is; but for the Proof thereof, I ſhall refer to ſome of our late *Engliſh* Authors, eſpecially ſome very late Experiments made before our moſt famous *R. S.* which will be ſo well improved by ſome of that illuſtrious Body, as to go near to put the Matter out of doubt.

(*f*) See

Fountains ſhould be high enough (*f*,) or the Seas low enough, ever to afford ſo long a Conveyance. Witneſs the *Danube* (*g*) and *Wolga* of *Europe*, the *Nile* (*h*) and the *Niger* (*i*) of *Africk*, the *Ganges* (*k*) and *Euphrates* of *Aſia*, and the *Amazons River* (*l*) and *Rio de la Plata* of *America*, and many others which might be named; ſome of which are ſaid to run above 5000 Miles, and ſome no leſs than 6000, from their Fountains to the Sea. And indeed ſuch prodigious Conveyances of the Waters make it manifeſt, that no accidental Currents and Alterations of the Waters themſelves, no Art or Power of Man, nothing leſs than the *Fiat* of the Almighty, could ever have made, or found, ſo long and commodious Declivities, and Channels for the Paſſage of the Waters.

(*f*) See *Book* III. *Chap.* 4.

(*g*) *The* Danube *in a ſober Account, performs a Courſe of above* 1500 *Miles*, (*i. e.* in a ſtrait Line) *from its Riſe to its Fall*. Bohun's Geogr. Dict.

(*h*) *Tractus* ſc. *Longitudo* [Nili] *eſt milliarium circiter* 630 *Germ. ſive Ital.* 2520, *pro quibus ponere licet* 3000 *propter curvaturas*. Varen. Geogr. l. 1. c. 16. p. 27.

(*i*) *Varene* reckons the Courſe of the *Niger*, at a middle Computation, 600 *German* Miles, that is 2400 *Italian*.

(*k*) That of the *Ganges* he computes at 300 *German* Miles. But if we add the Curvatures to theſe Rivers, their Channels are of a prodigious Length.

(*l*) *Oritur, flumen* (*quod plerumque Amazonum*, &c.) *haud procul Quito in montibus——Cum per leucas Hiſpanicas* 1356. *curſum ab occidente in orientem continuârit, oſtio* 84 *leucas lato——in Oceanum præcipitatur*. Chr. D'Acugna Relatio de flumine Amaz. in Act. Erud. Aug. 1683.

CHAP. VI.

The great Variety and Quantity of all Things upon, and in the Terraqueous Globe, provided for the Uſes of the World.

THE laſt Remark I ſhall make about the Terraqueous Globe in general is, the great Variety of Kinds, or Tribes, as well as prodigious Number of Individuals of each various Tribe, there is of all Creatures (*a*). There are ſo many Beaſts, ſo many Birds, ſo many Inſects, ſo many Reptiles, ſo many Trees, ſo many Plants upon the Land; ſo many Fiſhes, Sea-Plants, and other Creatures in the Waters; ſo many Minerals, Metals, and Foſſils in the Subterraneous Regions; ſo many *Species* of theſe *Genera*, ſo many *Individuals* of thoſe *Species*, that there is nothing wanting to the Uſe of Man, or any other Creature of

(*a*) *Non dat Deus beneficia? Unde ergò iſta quæ poſſides?——Unde hæc innumerabilia, oculos, aures & animum mulcentia? Unde illa luxuriam quoque inſtruens copia? Neque enim neceſſitatibus tantummodò noſtris proviſum eſt: uſque in delictas amamur. Tot arbuſta, non uno modo frugifera, tot herbæ ſalutares, tot varietates ciborum, per totum annum digeſtæ, ut inerti quoque fortuita terræ alimenta præberent. Jam animalia omnis generis, alia in ſicco, &c.——ut omnis rerum naturæ pars tributum aliquod nobis conferret.* Senec. de Benef. l. 4. c. 5. ubi plura vide.

Hic, ubi habitamus non intermittit ſuo tempore Cœlum niteſcere, arbores frondeſcere——tum multitudinem pecudum partim ad veſcendum, partim ad cultus agrorum, partim ad vehendum, partim ad corpora veſtienda; hominemque ipſum quaſi contemplatorem cœli ac deorum, ipſorumque cultorem.——Hæc igitur, & alia innumerabilia cùm cernimus, poſſumuſne dubitare, quin his præſit aliquis vel Effector, ſi hæc nata ſunt, ut Platoni videtur: vel ſi ſemper fuerint, ut Ariſtoteli placet, Moderator tanti operis & muneris? Cicer. Tuſc. Quæſt. l. 1. c. 28, 29.

(*b*) *Sunt*

of this lower World. If every Age doth change its Food, its way of Cloathing, its way of Building; if every Age (*b*) hath its Variety of Diſeaſes; nay, if Man, or any other Animal, was minded to change theſe Things every Day, ſtill the Creation would not be exhauſted, ſtill nothing would be wanting for Food, nothing for Phyſick, nothing for Building and Habitation, nothing for Cleanlineſs and Refreſhment, yea, even for Recreation and Pleaſure. But the Munificence of the Creator is ſuch, that there is abundantly enough to ſupply the Wants, the Conveniencies, yea, almoſt the Extravagancies of all the Creatures, in all Places, all Ages, and upon all Occaſions.

And this may ſerve to anſwer an Objection againſt the Excellency of, and Wiſdom ſhewed in, the Creation; namely, What need of ſo many Creatures (*c*)? Particularly of ſo many Inſects, ſo many Plants,

(*b*) *Sunt & gentium differentiæ non mediocres——quæ contemplatio refert rurſus nos ad ipſorum animalium naturas, ingenitaſque iis vel certiores morborum omnium medicinas. Enim verò rerum omnium Parens, nullum animal ad hoc tantum ut paſceretur, aut alia ſatiaret naſci voluit: arteſque ſalutares iis inſeruerit.* Plin. Nat. Hiſt. l. 27. c. 13.

(*c*) This was no very eaſy Queſtion to be anſwered by ſuch as held, That *all Things were made for Man*; as moſt of the Ancients did; as *Ariſtotle*, *Seneca*, *Cicero* and *Pliny*, (to name only ſome of the Chief.) And *Cicero* cites it as the celebrated *Chryſippus*'s Opinion, *Præclarè enim Chryſippus, Cætera nata eſſe Hominum Causâ, & Deorum.* De fin. bon. & mal. l. 3. And in his *De Nat. Deor. l. 2. fin.* he ſeriouſly proves the World it ſelf to have been made for the Gods and Man, and all Things in the World to have been made and contrived for the Benefit of Man, (*parata & inventa ad fructum Hominum*, are his Words.) So *Pliny* in his Preface to his 7th Book ſaith, Nature made all Things for Man; but then he makes a Doubt, Whether ſhe ſhewed her ſelf a more indulgent Parent, or cruel Step-Mother,

Plants, and ſo many other Things? And eſpecially of ſome of them, that are ſo far from being uſeful, that they are very noxious; ſome by their Ferity, and others by their poiſonous Nature, *&c.*

To which I might anſwer, That in greater Variety, the greater Art is ſeen; that the fierce, poiſonous, and noxious Creatures ſerve as Rods and Scourges to chaſtiſe us (*d*), as Means to excite our Wiſdom, Care, and Induſtry, with more to the ſame

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Mother, as in *Book* IV. *Chap.* 12. *Note* 2. But ſince the Works of God have been more diſcovered, and the Limits of the Univerſe have been found to be of infinitely greater Extent than the Ancients ſuppoſed them; this narrow Opinion hath been exploded. And the Anſwer will be found eaſy to theſe Queſtions, Why ſo many uſeleſs Creatures? In the Heavens, Why ſo many fix'd Stars, and the greateſt Part of them ſcarce viſible? Why ſuch Syſtems of Planets, as in *Jupiter*, *Saturn*, &c. (See my *Aſtro-Theology*.) In the Earth and Waters, Why ſo many Creatures of no uſe to Man?

(*d*) *Nec minùs clara exitii documenta ſunt etiam ex contemnendis animalibus. M. Varro author eſt à cuniculis ſuffoſſum in ad Hiſpaniâ opidum, à talpis in Theſſaliâ: à ranis civitatem in Galliâ pulſam, à locuſtis in Africâ: ex Gyaro, Cycladum inſulâ, incolas à muribus fugatos; In Italiâ Amyclas à ſerpentibus delatas. Citra Cynamolgos Æthiopas latè deſerta regio eſt, à ſcorpionibus & ſolpugis gente ſublatâ: & à ſcolopendris abactos Trevienſes, author eſt Theophraſtus.* Plin. Nat. Hiſt. l. 8. c. 29.

To theſe Inſtances may be added, the Plague they ſometimes ſuffer from a Kind of Mice (they call *Leming*, *Leminger*, *Lemmus*, &c.) in *Norway*, which eat up every green Thing. They come in ſuch prodigious Numbers, that they fancy them to fall from the Clouds; but *Ol. Magnus*, rather thinks they come from ſome of the Iſlands. *Hiſt. l.* 8. *c.* 2. If the Reader hath a mind to ſee a large Account of them, with a Diſpute about their Generation, a handſome Cut of them, with the Prayers, and an Exorciſm againſt them uſed in the Church of *Rome*, I ſhall refer him, (it being too tedious to recite in theſe Notes) to *Muſæum Wormian. l.* 3. *c.* 23.

Quare patimur multa mala à creaturâ quam fecit Deus, niſi quia offendimus Deum?—De pœnâ tuâ peccatum tuum accuſa, non judicem. Nam propter Superbiam inſtituit Deus creaturam iſtam minimam & abjec

ame Purpoſe. But theſe Things have been fully
rged by others; and it is ſufficient to ſay, that this
reat Variety is a moſt wiſe Proviſion for all the
Uſes of the World in all Ages, and all Places. Some
for

jectiſſimam, ut ipſa nos torqueret, ut cùm ſuperbus fuerit homo, & ſe
ctaverit adverſus Deum,——cùm ſe erexerit, Pulicibus ſubdatur.
uid eſt, quòd te inflat humanâ ſuperbiâ?—Pulicibus reſiſte, ut de-
ias. Cognoſce qui ſis. Nam propter ſuperbiam noſtram domandam
——creata illa quæ moleſta ſunt: populum Pharaonis ſuperbum potuit
us domare de Urſis, de, &c. Muſcas & Ranas illis immiſit, ut
us viliſſimis ſuperbia domaretur. Omnia ergo per ipſum——facta
t; & ſine ipſo factum eſt nihil. Auguſt. Tract. 1. in S. Johan.

But although the infinitely wiſe Creator hath put it in the
wer of ſuch vile Animals to chaſtiſe us, yet hath he ſhew-
no leſs Wiſdom and Kindneſs in ordering many, if not
oſt of them ſo, as that it ſhall be in the Power of Man, and
her Creatures, to obviate or eſcape their Evils. For, be-
es the noble Antidotes afforded by Minerals, Vegetables,
. many, if not moſt of our *European* venemous Animals
rry their Cure, as well as Poiſon, in their own Bodies. The
l, and I doubt not, the Body of *Scorpions* too, is a certain
emedy againſt its Stroke. A *Bee*, *Waſp*, or *Hornet*, cruſhed
d rubbed, and bound upon the Place, I have always found
be a certain Cure for the Sting of thoſe Creatures. And
ueſtion not, but the Fleſh, eſpecially the Head, of *Vipers*,
uld be found a Remedy for their Bites.

Our Viper-Catchers have a Remedy, in which they place ſo great Con-
nce, as to be no more afraid of the Bite [of a Viper,] *than of a*
mon Puncture, immediately curing themſelves by the Application of
r Specifick. This though they keep a great Secret, I have, upon
t Enquiry, found to be no other than Axungia Viperina, *preſently*
bed into the Wound. This Remedy the learned Doctor tried
mſelf with good Succeſs, in a young Dog that was bitten
the Noſe. *Vide Mead of Poyſons*, p. 29.

And as to the Means to eſcape the Miſchief of ſuch noxious
imals, beſides what may be effected by the Care, Induſtry,
d Sagacity of Man; ſome of them are ſo contrived and
de, as to give Warning or Time to Creatures in Danger
om them. Thus, for Inſtance, the *Rattle-Snake*, the moſt
iſonous of any Serpent, who darts its poiſonous Vapours to
me Diſtance, and in all Probability was the *Baſiliſk* of the
ncients, ſaid to kill with its Eyes, this involuntarily gives
arning by the Rattle in its Tail. So the *Shark*, the moſt ra-

pacious

for Food, ſome for Phyſick (*e*), ſome for Habitation, ſome for Utenſils, ſome for Tools and Inſtruments of Work, and ſome for Recreation and Pleaſure, either to Man, or to ſome of the inferior Creatures themſelves; even for which inferior Creatures, the Liberal Creator hath provided all Things neceſſary, or any ways conducing to their happy, comfortable living in this World, as well as for Man.

And it is manifeſt, that all the Creatures of God, Beaſts, Birds, Inſects, Plants, and every other *Genus*, have, or may have, their ſeveral Uſes even among Men. For although in one Place many Things may lie neglected, and out of Uſe, yet in other Places they may be of great Uſe. So what hath ſeemed uſeleſs in one Age, hath been received in another; as all the new Diſcoveries in Phyſick, and all the Alterations in Diet do ſufficiently witneſs. Many Things alſo there are which in one Form may be pernicious to Man; but in another of great Uſe. There are many Plants (*f*), many Animals, many Minerals, which

pacious Animal of the Waters, is forced to turn himſelf on his Back, (and thereby gives an Opportunity of Eſcape) before he can catch his Prey.

(*e*) *Hæc ſola Naturæ placuerat eſſe remedia parata vulgo, inventu facilia, ac ſine impendio, ex quibus vivimus. Poſteà fraudes hominum & ingeniorum capturæ officinas invenire iſtas, in quibus ſua cuique homini vœnalis promittitur vita. Statim compoſitiones & miſturæ inexplicabiles decantantur. Arabia atque India in medio æſtimantur, ulcerique parvo medicina à Rubro mari imputatur, cùm remedia vero quotidie pauperrimus quiſque vœnet.* Plin. l. 24. c. 1.

Non ſponte ſuâ ex tellure germinant Herbæ, quæ contra quoſcunque morbos accommodæ ſunt; ſed ea voluntate Opificis, ad noſtram utilitatem productæ ſunt. Baſil. Aſcet. Tom. 2.

Conſult here *Book X. Note* (*z*) (*aa*) (*bb*).

(*f*) Among poiſonous Vegetables, none more Famous of Old than *Hemlock*, accounted at this Day alſo very dangerous to Man, of which there are ſome diſmal Examples in our *Phi-*

Tra-

n one Form deſtroy, in another heal. The *Caſ-ada Plant* unprepared poiſoneth, but prepared, the very Bread of the *Weſt-Indies* (g), *Vipers* and

ranſ. Wepfer, &c. But yet this Plant is Food for *Goats*, and its eeds to *Buſtards*; and as *Gaier* ſaith, to *Starlings* alſo. Nei-er is this, ſo pernicious a Plant, only Food, but alſo Phyſick ſome Animals. An Horſe troubled with the *Farcy*, and uld not be cured with the moſt famed Remedies, cured mſelf of it in a ſhort Time, by eating *Hemlock*, of which he t greedily. *Vid. Phil. Tranſ.* No. 231. *And a Woman which as cured of the Plague, but wanted Sleep, did with very good Effect* Hemlock *for ſome Time; till falling ill again of a Fever, and ving left off the Uſe of this Remedy, he* [Nic. Fontanus] *endea-ured to procure her Reſt by repeated Doſes of* Opium, *which had no eration, till the Help of* Cicuta *was again called in with deſired ceſs.* Mead of Poiſ. p. 144.

And not only *Hemlock*, but many other, if not moſt Plants counted poiſonous, may have their great Uſe in Medicine; which take the Opinion of an able Judge, my ingenious d learned Friend Dr. *Tancred Robinſon*, in a Letter I have his to the late great Mr. *Ray*, of *Nov.* 7. 1604, viz. *According my Promiſe, I here ſend you a few Obſervations concerning ſome lants, ſeldom uſed in Medicine, being eſteemed poiſonous, which if cor-corrected, or exactly doſed, may perhaps prove the moſt powerful and ectual Medicines yet known.* Having then given an Account ſome of their Correctives, he gives theſe following Ex-mples, viz. 1. *The Hellebores incorporated with a Sapo, or Alkaly-lts alone, are ſucceſsful Remedies in Epilepſies, Vertigo's, Palſies, Le-argies, and Mania's. Doſ. a Scruple to ½ a Dram.* 2. *The Radic. Aſſari, cuta, and the Napellus, in Agues and periodical Pains. Doſ. a Scruple ½ a Dram.* 3. *The Hyoſcyamus in Hæmorrhagies, violent Heats and Per-rbation of the Blood, and alſo in all great Inflammations. Doſ. a Scruple ½ a Dram.* 4. *The Semen Stramoniæ is a very good Anodyne, uſeful in gilia's, Rheumatiſms, Hyſterick Caſes, in all the Orgaſms of the Blood or irits, and wherever there is an Indication for a Paregorick. Doſ. a Scruple ½ a Dram.* 5. *Elaterium thus corrected, may be given from gr. x. to . in Hydropical Caſes, without any ſenſible Evacuation or Diſturbance, may the Soldanella and Gratiola in greater Doſes.* 6. *Opium corrected afore-mentioned, loſes its Narcotick Faculty, and may be given very fely in great Doſes, and proves more than uſually prevalent in Convul-ve Caſes, Fluxes, Catarrhs, and all painful Paroxyſms*, &c.

(g) *It is of the moſt General Uſe of any Proviſion all over the* Weſt ndies, *eſpecially in the hotter Parts, and is uſed to victual Ships.*

Dr.

and *Scorpions*, and many Minerals, as deſtructive as they are to Man, yet afford him ſome of his beſt Medicines.

Or if there be many Things of little, immediate Uſe to Man, in this, or any other Age; yet to other Creatures they may afford Food or Phyſick, or be of ſome neceſſary Uſe. How many Trees and Plants, nay, even the very Carcaſes of Animals, yea, the very Duſt of the Earth (*h*), and the moſt refuſe contemptible Things to be met with; I ſay, how many ſuch Things are either Food, or probable Medicine to many Creatures, afford them Retreat, are Places of Habitation, or Matrixes for their Generation, as ſhall be ſhewed in proper Place. The prodigious Swarms of Inſects in the Air, and in the Waters, (many of which may be perhaps at preſent of no great Uſe to Man) yet are Food to Birds, Fiſhes, Reptiles, Inſects themſelves, and other Creatures (*i*), for whoſe happy and comfortable Subſiſtence, I have ſaid the Bountiful Creator hath liberally provided, as well as for that of Man.

Dr. Sloan's Nat. Hiſt. of *Jamaica*, Vol. 1. Ch. 5. Sect. 1.

(*h*) I have ſhewn in the *Philoſ. Tranſ.* that the *Pediculus fatidicus*, *Mortiſaga*, *Pulſatorius*, or *Death-Watch* there deſcribed feedeth upon Duſt; but that this Duſt they eat, is powdered Bread, Fruits, or ſuch like Duſt, not powdered Earth; as is manifeſt from their great Diligence and Curioſity in hunting among the Duſt. See more in *Philoſ. Tranſ.* No. 291.

(*i*) See *Book* IV. *Chap.* 11.

BOOK III.

f the Terraqueous Globe in Particular, more especially the EARTH.

HAVING thus taken a General Prospect of our Terraqueous Globe, I shall in this BOOK come to its Particulars. But here we have such an immense Variety pre-ting it self to our Senses, and such amazing Stro-s of Power and Wisdom, that it is impossible not be at a Stand, and very difficult to know where begin, how to proceed, or where to end. But must however attempt.

And for the more clear and regular Proceeding this copious Subject, I shall distribute the Globe o its own grand constituent Parts.

I. The *Earth* and its Appurtenances.

II. The *Waters* and Theirs.

The first of these only, is what at present I shall able to take into this SURVEY.

And in Surveying the *Earth*, I intend,

1. To consider its constituent Parts, or Things culiar to its self.

2. The Inhabitants thereof, or the several Kinds Creatures that have their Habitation, Growth, Subsistence thereon.

1. As to the Earth it self, the most remarkable hings that present themselves to our View, are,

1. Its various Moulds and Soils.

2. Its several Strata, or Beds.

3. Its

3. Its very Subterraneous Paſſages, Grotto's and Caverns.

4. Its Mountains and Vallies.

Chap. I. *Of the Soils and Moulds in the Earth.*

THE various Soils and Moulds are an admirable and manifeſt Contrivance of the All-wiſe Creator, in making this Proviſion for the various Vegetables (*a*), and divers other Uſes of the Creatures. For, as ſome Trees, ſome Plants, ſome Grain dwindle and die in a diſagreeable Soil, but thrive and flouriſh in others; ſo the All-wiſe Creator hath amply provided for every Kind a proper Bed.

If ſome Delight in a warm, ſome in a cold Soil; ſome in a lax or ſandy, ſome a heavy or clayie Soil; ſome in a Mixture of both, ſome in this, and that an

(*a*) It is not to be doubted, that although Vegetables delight in peculiar Soils, yet they owe not their Life and Growth to the Earth it ſelf, but to ſome agreeable Juices or Salts, &c. reſiding in the Earth. Of this the great Mr. *Boyle* hath given us ſome good Experiments. He ordered his Gardener to dig up, and dry in an Oven, ſome Earth fit for the Purpoſe, then weigh it, and to ſet therein ſome *Squaſh Seeds*, (a Kind of *Indian* Pompion.) The Seeds when ſown were watered with Rain or Spring-water only. But although a Plant was produced in one Experiment of near 3 Pounds, and in another of above 14 Pounds, yet the Earth when dried, and weighed again, was ſcarce diminiſhed at all in its Weight.

Another Experiment he alledges is of *Helmon*'s, who dried 200 Pounds, of Earth, and therein planted a Willow weighing 5 Pounds, which he watered with Rain, or diſtilled Water: And to ſecure it from any other Earth getting in, he covered it with a perforated Tin-Cover. After five Years, weighing the Tree with all the Leaves it had born in that Time, he found it to weigh 169 Pounds 3 Ounces, but the Earth to be diminiſhed only about 2 Ounces in its Weight. *Vide Boyle*'s *Scept. Chym. Part. 2. pag.* 114.

(*b*) The

nd the other Mould, ſome in moiſt, ſome in dry laces (*b*); ſtill we find Proviſion enough for all eſe Purpoſes: Every Country abounding with its roper Trees and Plants (*c*), and every Vegetable ouriſhing and gay, ſomewhere or other about the lobe, and abundantly anſwering the Almighty ommand of the Creator, when the Earth and Wa-rs were ordered to their peculiar Place, *Gen.* i. 11. *nd God ſaid, Let the Earth bring forth Graſs, he Herb yielding Seed, and the Tree yielding ruit after his Kind.* All which we actually ſee ſo.

To this Convenience which the various Soils that at the Earth are of to the Vegetables, we may ld their great Uſe and Benefit to divers Animals, many Kinds of Quadrupeds, Fowls, Inſects, and eptiles, who make in the Earth their Places of epoſe and Reſt, their Retreat in Winter, their

(*b*) Τὰς δὲ τόπους ζητεῖ τὰς οἰκείους, ἃ μόνον τὰ περιττὰ—— ὧν δένδρεων, &c. Τὰ μὲν γὰρ φιλεῖ ξηρὰς, τὰ δὲ ἐνύδρους, δὲ χειμερινὰς, τὰ δὲ τροχήλους, τὰ δὲ παλισκίους, καὶ ὅλως, μὲν ὀρεινὰς, τὰ δὲ ἐλώδεις.——Ζητεῖ γᾶρ τὰ πρόσφορα κατὰ κράσιν, ἔτι δὲ ἀσθενῆ, καὶ ἰσχυρὰ, καὶ βαθύῤῥιζα, καὶ πολαιόῤῥιζα, καὶ ἔστις ἄλλη διαφορὰ κατὰ τὰ μήρη——Πάντα ρ ταῦτα, ἔτι δὲ τὰ ὅμοια ζητεῖ τὸ ὅμοιον, καὶ τὰ ἀνόμοια τὸν αὐτὸν, ὅταν ἢ τις παραλλαγὴ τῆς φύσεως. *Theophraſt. Cauſ. Plant. l.* 2. *c.* 9.

(*c*) *Nec verò Terræ ferre omnes omnia poſſunt.*
Fluminibus Salices, craſſiſque paludibus Alni
Naſcuntur; ſteriles ſaxoſis montibus Orni:
Littora Myrtetis latiſſima: denique apertos
Bacchus amat colles: Aquilonem & frigora Taxi.
Aſpice & extremis domitum cultoribus orbem,
Eoaſque domos Arabum, pictoſque Gelonos:
Diviſa arboribus patriæ, &c. Vir. Georg. l. 2.

Security

Security from their Enemies, and their Nests to repose their Young; some delighting in a lax and pervious Mould, admitting them an easy Passage; and others delighting in a firmer and more solid Earth, that will better secure them against Injuries from without.

CHAP. II. *Of the various Strata, or Beds, observable in the* EARTH.

THE various *Strata* or *Beds*, although but little different from the last, yet will deserve a distinct Consideration.

By the *Strata*, or *Beds*, I mean those Layers of Minerals (*a*), Metals (*b*), Earth, and Stone (*c*), lying

(*a*) Altho' Minerals, Metals and Stones lie in Beds, and have done so ever since *Noah*'s Flood, if not from the Creation; yet it is greatly probable that they have Power of *growing* in their respective Beds: That as the Beds are robbed and emptied by Miners, so after a while they Recruit again. That *Vitriol*, Mr. *Boyle* thinks, will grow by the help of the Air. So *Alum* doth the same. *We are assured* (he saith) *by the experienced* Agricola, *That the Earth or Ore of* Alum, *being robbed of its Salt, will in Tract of Time recover it, by being exposed to the Air.* Boyl. Suspic. about some Hid. Qual. in the Air. *p.* 18.

(*b*) As to the Growth of *Metals*, there is great Reason to suspect that also, from what Mr. *Boyle* hath alledged in his *Observations about the Growth of Metals:* And in his *Scept. Chym. Part* 6. *pag.* 362. Compare also *Hakewil's Apol. pag.* 164.

And particularly as to the Growth of *Iron*, to the Instances he gives from *Pliny*, *Fallopius*, *Cæsalpinus*, and others; we may add, what is well known in the Forest of *Dean* in *Glocestershire*: That the best Iron, and most in Quantity, that is found there, is in the old Cinders, which they melt over again. That the Author of the *Additions to Glocestershire*, *in Cambden's Brit.* of the last Edition, *p.* 245. attributes to the Remissness of the former Melters, in not exhausting the Ore: But in all Probability it is rather to be attributed to the new Impregnation

c), lying under that upper *Stratum*, or Tegument f the Earth laſt ſpoken of, all of a prodigious Uſe Mankind: Some being of great Uſe for Build- g: ſome ſerving for Ornament; ſome furniſhing s with commodious Machines, and Tools to pre- are our Food, and for Veſſels and Utenſils, and for lultitudes of other Uſes; ſome ſerving for Firing dreſs our Food, and to guard us againſt the In- lts of Cold and Weather; ſome being of great Uſe

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the old Ore, or Cinders, from the Air, or from ſome ſemi- l Principle, or plaſtick Quality in the Ore it ſelf.

(*c*) As for the Growth of *Stone*, Mr. *Boyle* gives two Inſtan- s. One is that famous Place in *France*, called *Les Caves utieres: Where the Water falling from the upper Parts of the Cave he Ground, doth preſently there condenſe into little Stones, of ſuch ure, as the Drops, falling either ſeverally, or upon one another and gulating preſently into Stones, chance to exhibit.* Nid. Sceptic. ym. p. 360.

Such like Caves as theſe I have my ſelf met with in *Eng- d*; particularly on the very Top of *Bredon-Hill* in *Worceſter- re* near the *Precipice*, facing *Perſhore*, in or near the old For- ſs, called *Bembsbury-Camp*; I ſaw ſome Years ago ſuch a ve, which (if I miſ-remember not) was lined with thoſe *lactical-Stones* on the Top and Sides. On the Top they ng like Icicles great and ſmall, and many lay on the Ground. hey ſeemed manifeſtly to be made by an Exſudation, or xſtillation of ſome petrifying Juices out of the rocky Earth ere. On the Spot, I thought it might be from the Rains aking through, and carrying with it Impregnations from e Stone, the Hill being there all rocky. Hard by the ve is one or more vaſt Stones, which (if I miſtake not) are ruſtated with this Sparry, Stalactical Subſtance, if not holly made of it. But it is ſo many Years ago ſince I was the Place, and not being able to find my Notes about it, annot ſay whether the whole Stone is (in all Probability) ar, (as I think it is,) or whether I found it only caſed over th it, notwithſtanding I was very nice in examining it then, d have now ſome of the Fragments by me, conſiſting, a- ong other ſhining Parts, of ſome tranſparent angular ones.

The other Inſtance of Mr. *Boyle*, is from *Linſchoten*, who ith, that in the *Eaſt-Indies*, when they have cleared the Dia-

Uſe in Phyſick, in Exchange and Commerce, in manuring and fertilizing our Lands, in dying and colouring, and ten thouſand other Conveniences, too many to be particularly ſpoken of: Only there is one grand Uſe of one of theſe Strata or Beds, that cannot eaſily be omitted, and that is, thoſe ſubterraneous Strata of Sand, Gravel, and laxer Earth that admit of, and facilitate the Paſſage of the ſweet Waters (*d*), and may probably be the Colanders whereby they are ſweetened, and then at the ſame Time alſo convey'd to all Parts of the Habitable World, not only through the temperate and torrid Zones, but even the fartheſt Regions of the frozen Poles.

That theſe Strata are the *principal Paſſages* of the ſweet Fountain-Waters, is, I think, not to be doubted

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mond-Mines of all the Diamonds, *In a few Years time they find in the ſame Place new Diamonds produced.* Boyle Ibid.

(*d*) It is not only agreeable to Reaſon, but I am told by Perſons converſant in digging of Wells throughout this County of *Eſſex*, where I live, that the fureſt Beds in which they find Water, are *Gravel*, and a coarſe, dark coloured *Sand*; which Beds ſeldom fail to yield Plenty of ſweet Water: But for *Clay*, they never find Water therein, if it be a ſtrong, ſtiff *Clay*; but if it be lax and ſandy, ſometimes Springs are found in it; yet ſo weak, that they will ſcarcely ſerve the Uſe of the ſmalleſt Family. And ſometimes they meet with thoſe Beds lying next, under a looſe, black Mould, (which, by their Deſcription, I judged to be a ſort of oazy, or to have the Reſemblance of an ancient, ruſhy Ground,) and in that Caſe the Water is always naught, and ſtinks. And laſtly, Another ſort of Bed they find in *Eſſex*, in the Clayie-Lands particularly that Part called the *Rodings*, which yields Plenty of ſweet Water, and that is a Bed of white Earth, as though made of Chalk and white Sand. This they find, after they have dug through forty, or more Feet of Clay; and it is ſo tender and moiſt, that it will not lie upon the Spade, but they are forced to throw it into their Bucket with their Hands, with

loubted, conſidering that in them the Waters are vell known to paſs, and in them the Springs are ound by thoſe that ſeek for them: I ſay, the princi- al Paſſages, becauſe there are other ſubterraneous uts and Channels, Fiſſures and Paſſages, through hich many Times the Waters make their Way.

Now that which in a particular Manner doth em to me to manifeſt a ſpecial Providence of God the repoſiting theſe watery Beds is, that they ould be diſperſed all the World over, into all ountries, and almoſt all Tracts of Land: That ey ſhould ſo entirely, or for the moſt Part, con- of lax, incohering Earth, and be ſo ſeldom nded with other impervious Moulds, or if they ſo, it is commonly but accidentally; and that ey are interpoſed between the other impervious ds, and ſo are as a Prop and Pillar to guard them , and to prevent their ſinking in and ſhutting up Paſſages of the Waters.

The Time when thoſe Strata were laid, was doubt- s at the Creation, when *God ſaid* (Gen. i. 9.) *Let e Waters under the Heaven be gathered toge- er unto one Place, and let the dry Land ap- ar*; or elſe at the Deluge, if with ſome ſagacious aturaliſts, we ſuppoſe the Globe of Earth to have been

h Bowls; but when it comes up into the Air, it ſoon be- nes an hard white Stone.

Thus much for the Variety of Beds wherein the Waters are nd. That it is in theſe Beds only or chiefly the Springs , is farther manifeſt from the forcible Eruption of the ters ſometimes out of thoſe watery Beds. Of which ſee p. 4. *Note* (*k*). This Eruption ſhews, that the Waters come m ſome Eminence or other, lying at a Diſtance, and being fely pent up within the *watery Stratum*, by the Clayie Strata, e Waters with force mount up, when the Strata above are ened.

been dissolved by the Flood (*e*). At that Time (whatever it was) when the Terraqueous Globe, was in a Chaotick State, and the earthy Particles subsided, then those several Beds were in all Probability reposited in the Earth, in that commodious Order in which they now are found; and that, as is asserted, according to the Laws (*f*) of Gravity.

(*e*) *Vid.* Dr. *Woodward*'s Essay, Part 2. *Steno*'s Prodr. &c.

(*f*) *Id. ib. p.* 28, and 74. But Dr. *Leigh* in his *Nat. History of Lancashire*, speaking of the Coal-Pits, denies the Strata to lie according to the Laws of Gravitation, saying the Strata are a Bed of *Marle*, afterwards *Free-Stone*, next *Iron-Stone*, then *Coal* or *Kennel-Mine*, then some other Strata, and again *Coal*, &c.

But upon a stricter Enquiry into the Matter, finding I had reason to suspect that few, if any, actually had tried the Experiment, I was minded to bring the Thing to the Test of Experiment my self; and having an Opportunity, on *April*, 11. 171[illegible] I caused divers Places to be bored, laying the several *Strata* by themselves; which afterwards I weighed with all Strictness first in Air, then in Water, taking Care that no Air-Bubbles, &c. might obstruct the Accuracy of the Experiment. The Result was, that in my Yard, the Strata were gradually specifically heavier and heavier, the lower and lower they went; and the upper which was Clay, was considerably specifically lighter than the lower *Stratum*; which was first a loose Sand, then Gravel. In which *Stratum* principally the Springs run that supply my Well.

But in my Fields, where three Places were bored (to a great Depth) I found below the upper (superficial *Stratum*) a deep Bed of Sand only, which was of different Colours and Consistence, which I weighed as before, together with the Virgin-Mould; but they were all of the same, or nearly the same specifick Gravity, both out of the same Hole, and out of different Holes, although the Sand was at last so gravelly that it hinder'd our boring any deeper.

Upon this, fearing lest some Error might be in the former Experiments, I try'd them over again; and that with the same Success.

After this I made some Experiments in some deep Chalk Pits, with the Flints, Chalk, &c. above and below; but the Success was not so uniform as before.

Acquainting our justly Renowned *R. S.* with these Experiments, they ordered their Operator to experiment the *Strata* of a Coal-Pit; the Success whereof may be seen in *Phil. Trans.* No. 336.

CHAP.

CHAP. III.

Of the Subterraneous Caverns, and the Vulcano's.

I Shall take Notice of the ſubterraneous Caverns, Grotto's and Vulcano's, becauſe they are made n Objection (*a*) againſt the preſent Contrivance and ructure of the Globe. But, if well conſidered, ey will be found to be wiſe Contrivances of the reator, ſerving to great Uſes of the Globe, and nds of God's Government. Beſides many ſecret, and Functions and Operations of Nature in the owels of the Earth, that in all Probability theſe hings may miniſter unto, they are of great Uſe to e Countries where they are (*b*). To Inſtance in e very worſt of the Things named, *viz.* the *ulcano's* and ignivomous Mountains; although they

(*a*) *Nemo dixerit terram pulchriorem eſſe quòd cavernoſa ſit, quòd iſcat in multis locis, quòd diſrupta caveis & ſpatiis inanibus; iiſque llo ordine diſpoſitis, nullâ formâ: nec quæ aliud contineant quàm te-ras & ſordes; unde graves & peſtiferæ exhalationes, terræ motus,* c. Burnet ubi ſupr. c. 7.

(*b*) The *Zirchnitzer* Sea in *Carniola*, is of great Uſe to the habitants of that Country, by affording them Fiſh, Fowls, odder, Seeds, Deer, Swine, and other Beaſts, Carriage for eir Goods, &c. *Vid. Phil. Tranſ.* No. 191, &c, or *Lowth. bridg. Vol.* 2. *p.* 306, &c. where you have put together in e View, what is diſperſed in divers of the *Tranſactions.* his Sea or Lake proceeds from ſome ſubterraneous Grotto, Lake, as is made highly probable by Mr. *Valvaſor*, *Ibid.* The *Grotto Podpetſchio* may be another Inſtance, that the ry ſubterraneous Lakes may be of Uſe, even to the Inha-tants of the Surface above: Of which ſee *Lowth. ubi ſupr.* 317. *Sturmius* alſo may be conſulted here in his *Philoſ. clect. Exercit.* 11. *de Terræ mot.* particularly in *Chap.* 3. ſome f the moſt eminent Specus's are enumerated, and ſome of heir Uſes.

(*c*) *Crebri*

they are some of the most terrible Shocks of the Globe, and dreadful Scourges of the sinful Inhabitants thereof, and may serve them as Emblems, and Presages of Hell it self; yet even these have their great Uses too, being as Spiracles or Tunnels (*c*) to the Countries where they are, to vent the Fire and Vapours that would make dismal Havock, and oftentimes actually do so, by dreadful Successions and Convulsions of the Earth. Nay, if the Hypothesis of a central Fire and Waters be true, these Outlets seem to be of greatest Use to the Peace and Quiet of the Terraqueous Globe, in venting the subterraneous Heat and Vapours; which, if pent up, would make dreadful and dangerous Commotions of the Earth and Waters.

It may be then accounted as a special Favour of the Divine Providence, as is observed by the Author before praised (*d*), "That there are scarcely any "Countries, that are much annoyed with Earth-"quakes, that have not one of these fiery Vents. "And these (saith he) are constantly all in Flame "whenever any Earthquake happens, they disgor-"ging that Fire, which whilst underneath, was the "Cause of the Disaster. Indeed, (saith he,) were "it not for these *Diverticula*, whereby it thus "gaineth an *Exit*, 'twould rage in the Bowels of "the Earth much more furiously, and make greater "Havock than now it doth. So, that though "those Countries, where there are such *Vulcano's*, "are usually more or less troubled with Earth-

(*c*) *Crebri specus* [remedium] *præbent. Præconceptum enim spiritum exhalant: quod in certis notatur oppidis, quæ minus quatiuntur, crebris ad eluviem cuniculis cavata.* Plin. Hist. Nat. l. 2. c. 82.

(*d*) *Woodward's* Essay, Par. 3. Consect. 13.

"quakes;

"quakes; yet, were these *Vulcano's* wanting, they "would be much more annoyed with them than "now they are; yea, in all Probability to that De-"gree, as to render the Earth, for a vast Space "around them, perfectly uninhabitable. In one "Word, (saith he) so beneficial are these to the "Territories where they are, that there do not "want Instances of some which have been rescued, "and wholly delivered from Earthquakes by the "breaking forth of a new *Vulcano* there; this con-"tinually discharging that Matter, which being till "then barricaded up, and imprisoned in the Bowels "of the Earth, was the Occasion of very great and "frequent Calamities". Thus far that ingenious Author.

CHAP. IV. *Of the Mountains and Valleys.*

THE last Thing I shall take Notice of relating to the Earth, shall be the *Hills* and *Valleys*. These the eloquent *Theorist* owns to "contain "somewhat august and stately in the beholding of "them, that inspireth the Mind with great Thoughts "and Passions, that we naturally on such Occasions "think of God and his Greatness". But then, at the same Time he saith, "The Hills are the greatest "Examples of Ruin and Confusion; that they have "neither Form nor Beauty, nor Shape, nor Order, "any more than the Clouds in the Air; that they "consist not of any Proportion of Parts, referable "to any Design, nor have the least Footsteps of "Art or Counsel". Consequently one grand Part of this lower Creation, even the whole present Face

of our Terraqueous Globe, according to this ingenious Author, is a Work of mere Chance, a Structure in which the Creator did not concern himself.

Part of this Charge I have already briefly answered, and my Survey now leads me to shew, that the Mountains are so far from being a Blunder of Chance, a Work without Design, that they are a noble, useful, yea, a necessary Part of our Globe (*a*).

And in the first Place, as to the Business of Ornament, Beauty, and Pleasure, I may appeal to all Men's Senses, whether the grateful Variety of Hills and Dales, be not more pleasing than the largest continued Planes. Let those who make it their Business to visit the Globe, to divert their Sight with the various Prospects of the Earth; let these, I say, judge whether the far distant Parts of the Earth would be so well worth visiting, if the Earth was every where, of an even, level, globous Surface, or

(*a*) *Though there are some that think Mountains to be a Deformity to the Earth*, &c. *yet if well considered, they will be found as much to conduce to the Beauty and Conveniency of the Universe, as any of the other Parts. Nature* (saith Pliny) *purposely framed them for many excellent Uses; partly to tame the Violence of greater Rivers, to strengthen certain Joints within the Veins and Bowels of the Earth, to break the Force of the Sea's Inundation, and for the Safety of the Earth's Inhabitants, whether Beasts or Men. That they make much for the Protection of Beasts, the Psalmist testifies,* The highest Hills are a Refuge for the wild Goats, and the Rocks for Conies. *The Kingly Prophet had likewise learnt the Safety of those by his own Experience, when he also was fain to make a Mountain his Refuge from the Fury of his Master* Saul, *who prosecuted him in the Wilderness. True indeed, such Places as these keep their Neighbours poor, as being most barren, but yet they preserve them safe, as being most strong; witness our Unconquered* Wales *and* Scotland. ——*Wherefore a good Author doth rightly call them* Nature's Bulwarks, *cast up at God Almighty's Charges, the Scorns and Curbs of victorious Armies; which made the* Barbarians *in* Curtius, *so confident of their own Safety*, &c. Bishop *Wilkin's* World in the Moon, p. 114.

one

ne large Plane of many 1000 Miles; and not ra-
ner, as now it is, whether it be not far more plea-
ng to the Eye, to view from the Tops of the
lountains the ſubjacent Vales and Streams, and
e far diſtant Hills; and again from the Vales to
ehold the ſurrounding Mountains. The elegant
trains and lofty Flights, both of the ancient and
odern Poets on theſe Occaſions, are Teſtimonies
the Senſe of Mankind on this Configuration of
e Earth.

But be the Caſe as it will as to Beauty, which is
e leaſt valuable Conſideration, we ſhall find as to
onvenience, this Configuration of the Earth far
e moſt Commodious on ſeveral Accounts.

1. As it is the moſt ſalubrious, of great Uſe to
e Preſervation or Reſtoration of the Health of
lan. Some Conſtitutions are indeed of ſo happy
Strength, and ſo confirmed an Health, as to be
different to almoſt any Place or Temperature of
e Air: But then others are ſo weakly and feeble,
not to be able to bear one, but can live comfort-
ly in another Place. With ſome, the finer and
ore ſubtile Air of the Hills doth beſt agree, who
e languiſhing and dying in the feculent and groſſer
ir of great Towns, or even the warmer, and va-
orous Air of the Valleys and Waters: But con-
arywiſe others languiſh on the Hills, and grow
ſty and ſtrong in the warmer Air of the Valleys.

So that this Opportunity of ſhifting our Abode
om the warmer and more vaporous Air of the Val-
ys, to the colder and more ſubtile Air of the Hills,
r from the Hills to the Vales, is an admirable Eaſe-
ent, Refreſhment, and great Benefit to the vale-
dinarian, feeble Part of Mankind, affording thoſe

an

an easy and comfortable Life, who would otherwise live miserably, languish and pine away.

2. To this salutary Conformation of the Earth we may add another great Convenience of the Hills, and that is in affording commodious Places for Habitation: "Serving (as an eminent Author (*b*) wordeth it) "as Skreens to keep off the cold and "nipping Blasts of the Northern and Easterly "Winds, and reflecting the benign and cherishing "Sun-Beams, and so rendring our Habitations "both more comfortable and more chearly in "Winter; and promoting the Growth of Herbs "and Fruit-Trees, and the Maturation of the Fruits "in Summer.

3. Another Benefit of the Hills is, that they serve for the Production of great Varieties of Herbs and Trees (*c*). And as there was not a better Judge of those Matters, so I cannot give a better Account of this Convenience, than in the Words of the last cited famous Author, the late most eminent and learned Mr. *Ray* (*d*), (who hath so fully discussed this Subject I am upon, that it is scarce possible to tread out of his Steps therein.) His Observation is "That the Mountains do especially abound with "different

(*b*) Ray's *Wisdom of God*, &c. *p.* 251. *Dissolution of the World*, *p.* 35.

(*c*) *Theophrastus* having reckoned up the Trees that delight most in the Hills, and others in the Valleys, observeth, "Απαντα δὲ ὅσα κοινὰ τῶν ὀρῶν καὶ τῶν πεδίων, μείζω μὲν καὶ παχύλαίω τῇ ὕλῃ τὰ ἐν τοῖς πεδίοις γίνεται. κρείττω δὲ τῇ χρόσει τῶν ξύλων καὶ τῶν καρπῶν, τὰ ὀρεινά. *Theoph. Hist. Pl. l.* 3. *c.* 4. Απαντα δὲ ἐν τοῖς οἰκείοις τόποις καλλίω γίνεται, καὶ μᾶλλον εὐσθενεῖ.----Τὰ μὲν γὰρ φίλει τὰς ἐρυθρὰς καὶ ἐλώδεις.----Τὰ δὲ, τὰς εὐσκεπεῖς καὶ εὐηλίους. *Ib. l.* 4. *c.*

(*d*) *Wisdom of God*, p. 252.

(*e*) U

different Species of Vegetables, becauſe of the great Diverſity of Soils that are found there, every *Vertex* or Eminence almoſt, affording new Kinds. Now theſe Plants, (ſaith he,) ſerve partly for the Food and Suſtenance of ſuch Animals as are proper to the Mountains, partly for medicinal Uſes; the chief Phyſick, Herbs and Roots, and the beſt in their Kinds growing there: It being remarkable, that the greateſt and moſt luxuriant Species in moſt Genera of Plants are native of the Mountains.

4. Another Convenience which my laſt named learned Friend obſerves (*e*) is, "That the Mountains ſerve for the Harbour, Entertainment, and Maintenance of various Animals, Birds, Beaſts and Inſects, that breed, feed and frequent there. For, (ſaith he,) the higheſt Tops and Pikes of the *Alps* themſelves are not deſtitute of their Inhabitants, the *Ibex* or *Stein-buck*, the *Rupicapra* or *Chamois*, among Quadrupeds; the *Lagopus* among Birds. And I my ſelf (ſaith he) have obſerved beautiful *Papilio's*, and Store of other Inſects upon the Tops of ſome of the *Alpine* Mountains. Nay, the higheſt Ridges of many of theſe Mountains, ſerve for the Maintenance of Cattle, for the Service of the Inhabitants of the Valleys.

5. Another Thing he obſerves is, "That thoſe long Ridges and Chains of lofty and topping Mountains, which run through whole Continents Eaſt and Weſt (*f*), ſerve to ſtop the Evagation of "the

(*e*) *Ubi ſupra.*

(*f*) Many have taken Notice, that ſome of the greateſt Eminences of the World run generally Eaſt and Weſt, of which take

"the Vapours to the North and South in hot Coun-
"tries, condenſing them like Alembick-Heads into
"Water, and ſo (according to his Opinion) by a
"kind of external Diſtillation giving Original to
"Springs and Rivers; and likewiſe by amaſſing,
"cooling and conſtipating of them, turn them into
"Rain, by thoſe Means rendring the fervid Regi-
"ons of the torrid Zone habitable.

To theſe might be added ſome other Uſes and Conveniences (*g*); as that the Hills ſerve to the Generation of Minerals and Mettals (*h*), and that in them

take the late ingenious and learned Dr. *Nichols*'s Account, [*Confer. with a Theiſt*, Part 2. p. 191.] *To go no farther than our own Country, all our great Ridges of Hills in* England *run Eaſt and Weſt; ſo do the* Alps *in* Italy, *and in ſome Meaſure the* Pyrenees; *ſo do the Mountains of the Moon in* Africk, *and ſo do Mount* Taurus *and* Caucaſus. *This* (he ſaith) *is a wiſe Contrivance to prevent the Vapours, which would all run Northwards, and leave no Rains in the* Mediterranean *Countries.*

(*g*) That the Generation of many of the Clouds is owing to the Hills, appears from the Obſervations of the ingenious and learned Dr. *Joh. Jam. Scheuchzer* of *Zurich*, and Mr. *Joach. Frid. Creitlovius* cited by him. They obſerved at Sun-riſing, divers Clouds detatched by the Heat of the Sun, from ſome of the Tops of the *Alps*, &c. upon all which their Obſervations, the Concluſion is, *Mirati ſummam Creatoris ſapientiam, qui & id quod paulò antè nulli nobis uſui eſſe videbatur, maximis rebus deſtinaverat, adeòque ex illo tempore dubitare cœpi, num Nubes eſſent futuræ, ſi iſtiuſmodi Montes & Petra non darentur. Hypotheſi hâc ſtante, elucèſceret permagna utilitas, imò neceſſitas, quam* Helviticæ Alpes *non nobis tantùm accolis ſed & vicinis aliis regionibus præſtant, diſpenſando, quas gignunt Nubes, Ventos, Aquas.* Scheuch. Iter. Alpin. 2. p. 20.

(*h*) Let us take here *Ol. Mag.* Obſervation of his Northern Mountains; *Montes excelſi ſunt, ſed pro majori parte ſteriles, & aridi; in quibus ferè nil aliud pro incolarum commoditate & conſervatione gignitur, quàm inexhauſta pretioſorum Metallorum ubertas, quâ ſatis opulenti, fertileſque ſunt in omnibus vitæ neceſſariis, forſitan & ſuperfluis aliunde ſi libet conquirendis, unanimique robore, ac viribus, ubi vis contra hæc naturæ dona intentata fuerit, defendendis. Acre enim genus hominum eſt*, &c. Ol. Mag. Hiſt. l. 6. Præf. See alſo Sir *Robert Sibbald*'s Prodr. Nat. Hiſt. Scot. p. 47.

(*i*) See

them principally are the moſt uſeful Foſſiles found; or if not found and generated only in them, yet at leaſt all theſe ſubterraneous Treaſures are moſt eaſily come at in them: Alſo their Uſe to ſeveral Nations of the Earth, in being Boundaries and Bullwarks to them. But there is only one Uſe more that I ſhall inſiſt on, and that is,

6. And laſtly, That it is to the Hills that the Fountains owe their Riſe, and the Rivers their Conveyance. As it is not proper, ſo neither ſhall I here enter into any Diſpute about the Origin of Springs, commonly aſſigned by curious and learned Philoſophers. But whether their Origin be from condenſed Vapours, as ſome think (*i*); or from Rains falling, as others; or whether they are derived from the Sea by way of Attraction, Percolation, or Diſtillation; or whether all theſe Cauſes concur, or only ſome, ſtill the Hills are the grand Agent in this prodigious Benefit to all the Earth: Thoſe vaſt Maſſes and Ridges of Earth ſerving as ſo many huge *Alembicks* or *Cola* in this Noble Work of Nature.

But be the *Modus*, or the Method Nature takes in this Great Work as it will, it is ſufficient to my Purpoſe, that the Hills are a grand Agent in this ſo Noble and Neceſſary a Work: And conſequently, that thoſe vaſt Maſſes, and lofty Piles, are not as they are charged, ſuch rude and uſeleſs Excreſcences of our ill-formed Globe; but the admirable Tools of Nature, contrived and ordered by the Infinite Creator, to do one of its moſt uſeful Works, and to diſpenſe this Great Bleſſing to all Parts of the Earth; without which neither Animals could live, nor Vegetables ſcarcely

(*i*) See *Book* I. *Chap.* 3. *Note* (*b*). (*k*) *Mon-*

ſcarcely grow, nor perhaps Minerals, Metals, or Foſſiles receive any Increaſe. For was the Surface of the Earth even and level, and the middle Parts of its Iſlands and Continents, not mountainous and high, (as now it is) it is moſt certain there could be no Deſcent for the Rivers, no Conveyance for the Waters; but inſtead of gliding along thoſe gentle Declivities which the higher Lands now afford them quite down to the Sea, they would ſtagnate, and perhaps ſtink, and alſo drown large Tracts of Land.

But indeed, without Hills, as there could be no Rivers, ſo neither could there be any Fountains, or Springs about the Earth; becauſe, if we could ſuppoſe a Land could be well watered (which I think not poſſible) without the higher Lands, the Waters could find no Deſcent, no Paſſage through any commodious Out-lets, by Virtue of their own Gravity, and therefore could not break out into thoſe commodious Paſſages and Currents, which we every where almoſt find in, or near the Hills, and ſeldom, or never, in large and ſpacious Planes; and when we do find them in them, it is generally at great and inconvenient Depths of the Earth; nay, thoſe very ſubterraneous Waters, that are any where met with by digging in theſe Planes, are in all Probability owing to the Hills, either near or far diſtant: As among other Inſtances may be made out, from the forcible Eruption of the ſubterraneous Waters in digging Wells, in the *lower Auſtria*, and the Territories of *Modena*, and *Bologna* in *Italy*, mentioned by my fore-named learned Friend Mr. *Ray* (*k*). Or if there be

(*k*) *Monſieur* Blundel *related to the* Pariſian *Academy, what Device the Inhabitants of the* lower Auſtria, (*which is encompaſſed with*

e any ſuch Place found throughout the Earth, that devoid of Mountains, and yet well watered, as rhaps ſome ſmall Iſlands may; yet in this very aſe, that whole Maſs of Land is no other than as one ountain deſcending, (though unperceivedly) gent- down from the Mid-land Parts to the Sea, as moſt her Lands do; as is manifeſt from the Deſcent their Rivers, the Principal of which in moſt ountries have generally their Riſe in the more fty Mid-land Parts.

And now conſidering what hath been ſaid con- rning this laſt Uſe of the Hills, there are two or ee Acts of the Divine Providence obſervable erein. One is, that all Countries throughout the hole World, ſhould enjoy this great Benefit of ountains, placed here and there, at due and pro- per

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Mountains of Stiria] *are wont to uſe to fill their Wells with Wa- They dig in the Earth to the Depth of* 25 *and* 20 *Feet, till they e to an Argilla* [clammy Earth]——*which they bore through ſo , till the Waters break forcibly out; which Water it is probable comes n the neighbouring Mountains in ſubterraneous Channels. And* Caſ- us *obſerved, That in many Places of the Territory of* Modena *and* logna *in* Italy, *they make themſelves Wells by the like Artifice*, &c. *this Means the ſame* Seig. Caſſini *made a Fountain at the Caſtle* Urbin, *that caſt up the Water* 5 *Feet high above the Level of the ound.* Ray's Diſ. 1. pag. 40. ubi plura.

Upon Enquiry of ſome ſkilful Workmen, whoſe Buſineſs it to dig Wells, &c. whether they had ever met with the like ſe, as theſe in this Note, they told me they had met with in *Eſſex*, where after they had dug to 50 Feet Depth, the an in the Well obſerved the clayie Bottom to ſwell and be- n to ſend out Water, and ſtamping with his Foot to ſtop the ater, he made Way for ſo ſuddain and forcible a Flux of ater, that before he could get into his Bucket, he was above Waſte in Water; which ſoon aſcended to 17 Feet height, d there ſtayed: And although they often, with great La- ur endeavoured to empty the Well, in order to finiſh their ork, yet they could never do it, but were forced to leave it it was.

(*l*) As

per Diſtances, to afford theſe ſeveral Nations this excellent and moſt neceſſary Element the Waters. For according to Nature's Tendency, when the Earth and Waters were ſeparated, and order'd to their ſeveral Places, the Earth muſt have been of an even Surface, or nearly ſo. The ſeveral component Parts of the Earth, muſt have ſubſided according to their ſeveral ſpecifick Gravities, and at laſt have ended in a large, even, ſpherical Surface, every where equidiſtant from the Centre of the Globe. But that inſtead of this Form, ſo incommodious for the Conveyance of the Waters, it ſhould be jetted out every where into Hills and Dales, ſo neceſſary for that Purpoſe, is a manifeſt Sign of an eſpecial Providence of the Wiſe Creator.

So another plain Sign of the ſame eſpecial Providence of God, in this Matter, is that generally throughout the whole World, the Earth is ſo diſpos'd, ſo order'd, ſo well-laid; I may ſay, that the Mid-land Parts, or Parts fartheſt from the Sea, are commonly the higheſt: Which is manifeſt, I have ſaid, from the Deſcent of the Rivers. Now this is an admirable Proviſion the Wiſe Creator hath made for the commodious Paſſages of the Rivers, and for draining the ſeveral Countries, and carrying off the ſuperfluous Waters from the whole Earth; which would be as great an Annoyance, as now they are a Convenience.

Another providential Benefit of the Hills ſupplying the Earth with Water, is, that they are not only inſtrumental thereby, to the Fertility of the Valleys but to their own alſo (*l*); to the Verdure of the Vegetable

(*l*) As the Hills being higher, are naturally diſpoſed to be dri

Vegetables without, and to the Increment and Vigour of the Treaſures within them.

Thus having vindicated the preſent Form and Fabrick of the Earth, as diſtributed into Mountains and Valleys, and thereby ſhewn in ſome Meaſure the Uſe thereof, particularly of the Mountains, which are chiefly found Fault with: I have, I hope, made it in ſome Meaſure evident, that God was no idle Spectator (*m*,) nor unconcerned in the ordering of the Terraqueous Globe, as the former bold Charges againſt it do infer; that he did not ſuffer ſo grand a Work, as the Earth, to go unfiniſh'd out of his Almighty Hand; or leave it to be ordered by Chance, by natural Gravity, by caſual Earthquakes, &c. but that the noble Strokes, and plain Remains of Wiſdom and Power therein, do manifeſt it to be his Work. That particularly the Hills and Vales, though to a peeviſh weary Traveller, they may ſeem incom-

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ier than the Valleys; ſo kind Nature hath provided the greater Supplies of Moiſture for them, ſuch at leaſt of them do not aſcend above the Clouds and Vapours. For, beſides the Fountains continually watering them, they have more Dews and Rains commonly than the Valleys. They are more frequently covered with Fogs; and by retarding, ſtopping, and compreſſing the Clouds, or by their greater Colds condenſing them, they have larger Quantities of Rain fall upon them. As I have found by actual Experience, in comparing my Obſervations with thoſe of my late very curious and ingenious Correſpondent, *Richard Townley*, Eſq; of *Lancaſhire*, and ſome others, to be met with before, *Chap.* 2. *Note* (*a*). From which it appears, that above double the Quantity of Rain falleth in *Lancaſhire*, than doth at *Upminſter*. The Reaſon of which is, becauſe *Lancaſhire* hath more, and much higher Hills than *Eſſex* hath. See *Book* II. *Chap.* 5. *Note* (*e*).

(*m*) *Accuſandi ſanè meâ ſententiâ hic ſunt Sophiſtæ, qui cùm nondum venire, neque exponere opera Naturæ queant, eam tamen inertiâ atque ſcitiâ condemnant*, &c. Galen. de Uſ. Part 1, l. 10. c. 9.

incommodious and troublesome; yet are a noble Work of the Great Creator, and wisely appointed by him for the Good of our sublunary World.

And so for all the other Parts of our Terraqueous Globe, that are presumed to be found Fault with by some, as if carelesly order'd, and made without any Design or End; particularly the Distribution of the dry Land and Waters; the laying the several Strata or Beds of Earth, Stone, and other Layers before spoken of; the Creation of noxious Animals, and poisonous Substances, the boisterous Winds; the Vulcano's, and many other Things which some are angry with, and will pretend to amend: I have before shewn, that an Infinitely Wise Providence, an Almighty Hand was concerned even in them; that they all have their admirable Ends and Uses, and are highly instrumental and beneficial to the Being, or Well-being of this our Globe, or to the Creatures residing thereon.

So also for Human Bodies, it hath been an Ancient (*n*), as well as Modern Complaint, that our Bodies are not as big as those of other Animals; that we cannot run as swift as Deer, fly like Birds, and that we

(*n*) *Vide quàm iniqui sint divinorum munerum æstimatores, etiam quidam professi sapientiam. Queruntur quòd non magnitudine corporis æquemus Elephantes, velocitate Cervos, levitate Aves, impetu Tauros; quòd solidior sit cutis Belluis, deceptior Damis, densior Ursis, multis Fibris; quòd sagacitate nos narium Canes vincant, quòd acie luminum Aquilæ, spatio ætatis Cervi, multa Animalia nandi facilitate. Et cùm quædam nè coire quidem in idem Natura patiatur, ut velocitatem corporis & vires pares animalibus habeamus; ex diversis & dissidentibus bonis Hominem non esse compositum, injuriam vocant; & in negligentes nostri Deos querimoniam jaciunt, quòd non bona valetudo, & vitiis inexpugnabilis data sit, quòd non futuri scientia. Vix sibi temperant quin eousque impudentiæ provehantur, ut Naturam oderint, quòd infra Deos sumus, quòd non in æquo illis stetimus.* Seneca de Benef. lib. 2. cap. 29.

(*o*) *Quam*

we are out-done by many Creatures in the Accuracy of the Senſes, with more to the ſame Purpoſe. But theſe Objections are well anſwered by *Seneca* (*o*), and will receive a fuller Solution from what I ſhall obſerve of Animal Bodies hereafter.

But indeed, after all, it is only for want of our knowing theſe Things better, that we do not admire (*p*) them enough; it is our own Ignorance, Dulneſs or Prejudice, that makes us charge thoſe noble Works of the Almighty, as Defects or Blunders, as ill-contriv'd, or ill-made.

It is therefore fitter for ſuch finite, weak, ignorant Beings as we, to be humble and meek, and conſcious of our Ignorance, and jealous of our own Judgment, when it thus confronteth Infinite Wiſdom. Let us remember how few Things we know, how many we err about, and how many we are ignorant of: And thoſe, many of them, the moſt familiar, obvious Things: Things that we ſee and handle at Pleaſure; yea, our own very Bodies, and that very Part of us whereby we underſtand at all, our Soul. And ſhould we therefore pretend to cenſure what God doth! Should we pretend to amend his Work! Or to adviſe Infinite Wiſdom! Or to know the Ends and Purpoſes of his Infinite Will, as if

(*o*) *Quanto ſatiùs eſt ad contemplationem tot tantorumqae beneficiorum reverti, & agere gratias, quòd nos in hoc pulcherrimo domicilio voluerunt* (Dii) *ſecundos ſortiri, quòd terrenis præfecerunt.* Then having reckoned up many of the Privileges and Benefits, which the Gods, he ſaith, have conferred upon us, he concludes, *Ita eſt: cariſſimos nos habuerunt Dii immortales, habentque. Et qui maximus tribui honos potuit, ab ipſis proximos collocaverunt. Magna accepimus, majora non cepimus.* Senec. Ibid.

(*p*) *Naturam maximè admiraberis, ſi omnia ejus opera perluſtràris.* Galen. de Uſ. Part. l. 11. concluſ.

if we were of his Council! No, let us bear in Mind, that theſe Objections are the Products, not of Reaſon, but of Peeviſhneſs. They have been incommoded by Storms and Tempeſts; they have been terrify'd with the burning Mountains, and Earthquakes; they have been annoy'd by the noxious Animals, and fatigu'd by the Hills; and therefore are angry, and will pretend to amend theſe Works of the Almighty. But in the Words of St. *Paul* (*q*), we may ſay, *Nay, but O Man, who art thou that replieſt againſt God? Shall the Thing formed ſay to him that formed it, Why haſt thou made me thus? Hath not the Potter power over the Clay, of the ſame Lump, to make one Veſſel to honour, and another to diſhonour?* If the Almighty Lord of the World, had for his own Pleaſure, made this our World more inconvenient for Man, it would better become us to ſit ſtill, and be quiet; to lament our own great Infirmities and Failings, which deſerve a worſe Place, a more incommodious Habitation, than we meet with in this elegant, this well-contriv'd, well-form'd World, in which we find every Thing neceſſary for the Suſtentation, Uſe and Pleaſure, both of Man, and every other Creature here below; as well as ſome Whips, ſome Rods to ſcourge us for our Sins (*r*).

But

(*q*) Rom. ix. 20, 21.

(*r*) *Neither are they* [noxious Creatures] *of leſs Uſe to amend our Minds, by teaching us Care and Diligence, and more Wit. And the much the more, the worſe the Things are we ſee, and ſhould avoid.* Weezels, Kites, *and other miſchievous Animals, enduce us to a Watchfulneſs:* Thiſtles *and* Moles *to good Husbandry*; Lice *oblige us to Cleanlineſs in our Bodies*; Spiders *in our Houſes*; *and the* Moth *in our Clothes. The Deformity and Filthineſs of* Swine, *make them the Beauty-Spot of the Animal-Creation, and the Emblems of all Vice.*

To

But yet ſo admirable well-temper'd is our State, ſuch an Accord, ſuch an Harmony is there throughout the Creation, that if we will but purſue the Ways of Piety and Virtue, which God hath appointed; if we will form our Lives according to the Creator's Laws, we may eſcape the Evils of this our frail State, and find ſufficient Means to make us happy whilſt we are in the Body. The natural Force and Tendency of our Virtue, will prevent many of the Harms (*s*), and the watchful Providence of our Almighty Benefactor, will be a Guard againſt others; and then nothing is wanting to make us happy, as long as we are in this World, there being abundantly enough to entertain the Minds of the moſt contemplative; Glories enough to pleaſe the Eye of the moſt curious and inquiſitive; Harmonies and Conſorts of Nature's own, as well as Man's making, ſufficient to delight the Ear of the moſt harmonious and muſical; All Sorts of pleaſant Guſto's to gratify the Taſte and Appetite, even of the moſt luxurious; And fragrant Odours to pleaſe the niceſt and tendereſt Smell: And in a Word, enough to make us love and delight in this World, rather too much, than too little, conſidering how nearly we are ally'd to another World, as well as this.

—*The Truth is, Things are hurtful to us only by Accident; that is, not of Neceſſity, but through our own Negligence or Miſtake. Houſes decay, Corn is blaſted, and the Weezel breeds in Mault, ſooneſt towards the South. Be it ſo, it is then our own Fault, if we uſe not the Means which Nature and Art have provided againſt theſe Inconveniences.* Grew's Coſmol. c. 2. Sect. 49, 50.

(*s*) *Non eſt gemendus, nec gravi urgendus nece,*
Virtute quiſquis abſtulit fatis iter.
Senec. Hercul. Oet. Act. 5. Car. 1833.
Nunquam Stygias fertur ad umbras
Inclyta virtus. Id. Ibid. Car. 1982.

BOOK IV.

Of ANIMALS in General.

IN the laſt BOOK, having ſurvey'd the Earth it ſelf in Particular, I ſhall next take a View of the Inhabitants thereof; or the ſeveral Kinds of Creatures (*a*), that have their Habitation, Growth, or Subſiſtence thereon.

Theſe Creatures are either Senſitive, or Inſenſitive Creatures.

In ſpeaking of thoſe endow'd with Senſe, I ſhall conſider:

I. Some Things common to them all.

II. Things peculiar to their Tribes.

I. The Things in common, which I intend to take Notice of, are theſe Ten:

1. The Five *Senſes*, and their Organs.

2. The great Inſtrument of Vitality, *Reſpiration*.

3. The *Motion*, or Loco-motive Faculty of Animals.

4. The *Place*, in which they live and act.

5. The *Balance* of their Numbers.

(*a*) *Principio cœlum, ac terras, camposque liquentes,*
Lucentemque globum Lunæ, Titaniaque aſtra
Spiritus intùs alit, totamque infuſa per artus
Mens agitat molem, & magno ſe corpore miſcet.
Inde hominum, pecudumque genus, vitæque volantum,
Et quæ marmoreo fert monſtra ſub æquore pontus,
Igneus eſt illis vigor, & cœleſtis origo
Seminibus.

Virgil. Æneid. L. 6. Carm. 724.

6. Their

6. Their *Food.*
7. Their *Cloathing.*
8. Their *Houſes, Neſts* or *Habitations.*
9. Their Methods of *Self-Preſervation.*
10. Their *Generation* and *Conſervation* of their Species by that Means.

CHAP. I. *Of the Five Senſes in General.*

THE firſt Thing to be conſider'd, in common to all the Senſitive Creatures, is, their Faculty of *Seeing, Hearing, Smelling, Taſting*, and *Feeling*; and the *Organs* miniſtring to theſe five *Senſes*, together with the exact Accommodation of thoſe Senſes, and their Organs, to the State and Make of every Tribe of Animals (*a*). The Conſideration of which Particulars alone, were there no other Demonſtrations of God, is abundantly ſufficient to evince the Infinite Wiſdom, Power and Goodneſs of the Great Creator. For, who can but ſtand amaz'd at the Glories of theſe Works! At the admirable Artifice of them! And at their noble Uſe and Performances! For ſuppoſe an Animal, as ſuch, had Breath and Life, and could move it ſelf hither and thither; yet how could it know whither to go, what it was about, where to find its Food, how to avoid thouſands of Dangers (*b*), without Sight! How could Man,

(*a*) *Ex ſenſibus ante cætera Homini Tactus, deinde Guſtatus: reliquis ſuperatur à multis. Aquilæ clariùs cernunt:. Vultures ſagaciùs odorantur, liquidiùs audiunt Talpæ obrutæ terrâ, tam denſo atque ſurdo naturæ elemento.* Plin. Nat. Hiſt. l. 10. c. 69.

(*b*) *Subjacent Oculi, pars corporis pretioſiſſima, & qui lucis uſu vitam diſtinguant à morte.* Plin. Nat. Hiſt. l. 11. c. 37.

Man, particularly, view the Glories of the Heavens, ſurvey the Beauties of the Fields, and enjoy the Pleaſure of beholding the noble Variety of diverting Objects, that do, above us in the Heavens, and here in this lower World, preſent themſelves to our View every where; how enjoy this, I ſay, without that admirable Senſe of *Sight* (*c*)! How could alſo the Animal, without *Smell* and *Taſte*, diſtinguiſh its Food, and diſcern between wholeſome and unwholſome; beſides the Pleaſures of delightful Odours, and reliſhing Guſto's! How, without that other Senſe of *Hearing*, could it diſcern many Dangers that are at a Diſtance, underſtand the Mind of others, perceive the harmonious Sounds of Muſick, and be delighted with the Melodies of the winged Choir, and all the reſt of the Harmonies the Creator hath provided for the Delight and Pleaſure of his Creatures! And laſtly, How could Man, or any other Creature diſtinguiſh Pleaſure from Pain, Health from Sickneſs, and conſequently be able to keep their Body ſound and entire, without the Senſe of *Feeling!* Here, therefore, we have a Glorious OEconomy in every Animal, that commandeth Admiration, and deſerveth our Contemplation: As will better appear by coming to Particulars, and diſtinctly conſidering the Proviſion which the Creator hath made for each of theſe Senſes.

(*c*) *Fœminæ aliquæ Megarenſes ſolis oculis diſcernere valebant inter Ova quæ ex Gallinâ nigrâ, & quæ ex albâ natæ ſunt*, is what is affirmed (how truly I know not) by *Grimald. de Lumin. & Color. Pr.* 43. *Sect.* 60.

CHAP.

CHAP. II. *Of the Eye.*

FOR our clearer Proceeding in the Conſideration of this noble Part (*a*), and underſtanding its OEconomy, I ſhall conſider:

1. The *Form* of the Eye.
2. Its *Situation* in the Body.
3. Its *Motions*.
4. Its *Size*.
5. Its *Number*.
6. Its *Parts*.
7. The *Guard* and *Security* Nature hath provided for this ſo uſeful a Part.

As this eminent Part hath not been pretermitted by Authors, that have made it their particular Deſign and Buſineſs to ſpeak of the Works of GOD; divers of the aforeſaid Particulars have been touched upon by them. And therefore I ſhall take as little as poſſible of what they have ſaid, and as near as I can, mention chiefly what they have omitted. And,

1. For

(*a*) *In Diſſectionibus anatomicis vix aliquid admirabilius, aut artificioſius ſtructurâ Oculi humani, meo quidem judicio, occurrit: ut merito, per excellentiam, Creatoris appelletur Miraculum.* Gul. Fabr. Hildan. Cent. 2. Obſerv. 1.

So likewiſe that accurate Surveyor of the Eye, Dr. *Briggs*, whoſe *Ophthalmography* I have met with ſince my penning this Part of my Survey. His Character of this curious piece of God's Work is, *Inter præcipuas corporis animati partes, quæ Magni Conditoris noſtri ſapientiam oſtendunt, nulla ſanè reperitur, quæ majori pompâ elucet quàm ipſe Oculus, aut quæ elegantiori formâ concinnatur. Dum enim aliæ partes vel minori ſatellitio ſtipantur, vel in tantam amœnitatem haud aſſurgunt; Ocelli peculiarem honorem & decus à ſummo Numine efflatum referunt, & nunquam non ſtupenda ſuæ Potentiæ characteres repræſentant. Nulla ſanè pars tam divino artificio & ordine, &c.* Cap. 1. Sect. 1.

(*b*) It

1. For the *Form* of the Eye; which is for the most part Globous, or somewhat of the sphæroidal Form, which is far the more commodious optical Form, as being fittest to contain the Humours within, and to receive the Images of Objects from without (*b*). Was it a Cube, or of any multangular Form, some of its Parts would lie too far off (*c*), and some too nigh those lenticular Humours, which by their Refractions cause Vision. But by Means of the Form before-mentioned, the Humours of the Eye are commodiously laid together, to perform their Office of Refraction; and the *Retina*, and every other Part of that little darkned Cell, is neatly adapted regularly to receive the Images from without, and to convey them accordingly to the common Sensory in the Brain.

(*b*) It is a good Reason *Friar Bacon* assigns for the Sphæricity of the Eye: *Nam si esset planæ figuræ, species rei majoris non posset cadere perpendiculariter super eum——Cùm ergò Oculus videt magna corpora, ut ferè quartam cœli uno aspectu, manifestum est, quod non potest esse planæ figuræ, nec alicujus nisi sphæricæ, quoniam super sphæram parvam possunt cadere perpendiculares infinitæ, quæ à magno corpore veniunt, & tendunt in centrum Sphæræ: Et sic magnum corpus potest ab oculo parvo videri.* For the Demonstration of which he hath given us a Figure. *Rog. Bacon. Perspect. Distinct. 4. Cap. 4.*

Dr. *Briggs* saith, *Pars antica, (sive Cornea,) convexior est posticâ: hâc enim ratione radii melius in pupillam detorquentur, & Oculi fundus ex alterâ parte in majorem (propter imagines rerum ibidem delineandas) expanditur.* Ibid. Sect. 2.

(*c*) Suppose the Eye had the *Retina*, or back part, flat for the Reception of the Images, as in *Fig.* 1. ABA: it is manifest, that if the Extremes of the Image AA were at a due focal Distance, the middle B would be too nigh the Crystalline, and consequently appear confused and dim; but all Parts of the *Retina* lying at a due focal Distance from the Crystalline as at ACA, therefore the Image painted thereon is seen distinct and clear. Thus in a dark Room, with a Lens at a Hole in the Window, (which *Sturmius* calls his Artificial Eye, in his *Exercit. Acad.* one of which he had made for his Pupils, to run any where on Wheels.) In this Room, I say, if the Paper

To this we may add the Aptitude of this Figure the Motion of the Eye, for it is neceſſary for e Eye to move this way, and that way, in order adjuſt it ſelf to the Objects it would view; ſo this Figure it is well prepared for ſuch Motions, that it can with great Facility and Dexterity rect it ſelf as occaſion requires.

And as the Figure, ſo no leſs commodious is,

2. The *Situation* of the Eye, namely, in the ead (*d*), the moſt erect, eminent Part of the dy, near the moſt ſenſible, vital Part, the Brain. its Eminence in the Body, it is prepar'd to take the more (*e*) Objects. And by its Situation in Head, beſides its Proximity to the Brain, it is the moſt convenient Place for Defence and Secuy. In the Hands, it might indeed (in Man) be nder'd more eminent than the Head, and be turnabout here and there at pleaſure: But then it uld be expoſed to many Injuries in that active rt, and the Hands (*f*) render'd a leſs active and ful Part. And the like may be ſaid to its Sight, in

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t receives the Images be too nigh, or too far off the Lens, e Image will be confuſed and dim; but in the Focus of the laſs, diſtinct, clear, and a pleaſant Sight.

(*d*) *Blemmyis traduntur capita abeſſe, Ore & Oculis pectori affixis.* n. Nat. Hiſt. l. 5. c. 8. *Occidentem versùs quoſdam ſine cervice ulos in humeris habentes.* Ib. l. 7. c. 2. From theſe, and oer ſuch like Fables, in this laſt cited Chapter of *Pliny*, no ubt our famous Romancer Sir *J. Mandevile*, had his Roantick Stories related in his Travels.

(*e*) See *Book* V. *Chap.* 2. *Note* (*e*).

(*f*) *Galen* deſerves to be here conſulted, who in his Book *Uſu Partium*, from many Conſiderations of the Hand, ſuch what is here mentioned, as alſo its Structure, Site and ſe, largely proves and reflects upon the Wiſdom and Prodence of the Contriver and Maker of that Part.

(*g*) Thus

in any other Part of the Body, but where it is. But in the Head, both of Man, and other Animals, it is placed in a Part that ſeems to be contrived and made, chiefly for the Action of the principal Senſes.

Another Thing obſervable in the Sight of the Eye, is the manner of its Situation in the Head, in the Fore-part, or Side-part thereof, according to the particular Occaſions of particular Animals. In Man and ſome other Creatures, it is placed to look directly forward chiefly; but withal it is ſo order'd, as to take in near the Hemiſphere before it. In Birds and ſome other Creatures, the Eyes are ſo ſeated as to take in near a Whole Sphere, that they may the better ſeek their Food, and eſcape Dangers. And in ſome Creatures they are ſeated, ſo as to ſee both behind them (*g*), or on each Side, whereby they are enabled to ſee their Enemy that purſues them that Way, and ſo make their Eſcape.

And for the Aſſiſtance of the Eyes, and ſome of the other Senſes in their Actions; the Head is generally made to turn here and there, and move as Occaſion requires. Which leads me to the,

3. Thing to be remarked upon, the *Motions* of the Eye it ſelf. And this is generally upwards, downwards, backwards, forwards, and every Way (*h*), for the better, more eaſy, and diſtinct Reception of the viſual Rays. But

(*g*) Thus in *Hares* and *Conies*, their Eyes are very protuberant, and placed ſo much towards the Sides of their Head, that their two Eyes take in nearly a whole Sphere: Whereas in *Dogs*, (that purſue them) the Eyes are ſet more forward in the Head, to look that Way more than backward.

(*h*) *Sed lubricos Oculos fecit* [Natura] *& mobiles, ut & declinarent ſiquid noceret; & aſpectum, quo vellent, facilè converterent.* Cicer. de Nat. Deor. l. 2. c. 57.

(*i*) The

But where Nature any way deviateth from this ethod, either by denying Motion to the Eyes, or e Head (*i*), it is a very wonderful Proviſion ſhe th made in the Caſe. Thus for a Remedy of is Inconvenience, in ſome Creatures their Eyes e ſet out at a Diſtance (*k*) from the Head, to be cir- mvolved here and there; or, one this, the other at Way, at Pleaſure. And in Creatures, whoſe yes are without Motion, as in divers Inſects; in is Caſe, either they have more than two Eyes, or their

(*i*) *The Eyes of* Spiders, (in ſome four, in ſome ſix, and in me eight) *are placed all in the fore-front of their Head,* (*which is nd, and without any Neck,*) *all diaphanous and tranſparent, like a cket of Diamonds,* &c. *neither wonder why Providence ſhould be ſo malous in this Animal, more than in any other we know of. For, Since they wanting a Neck, cannot move their Head, it is requiſite t Defect ſhould be ſupplied by the multiplicity of Eyes.* 2. *Since they re to live by catching ſo nimble a Prey as a Fly is, they ought to ſee every Way, and to take her* per ſaltum, (*as they do*) *without any tion of the Head to diſcover her: Which Motion would have ſcared ay ſo timorous an Inſect.* Power's Microſ. Obſerv. p. 11.

The Eyes of the Cameleon *reſemble a Lens, or Convex-Glaſs, ſet in erſatile globular Socket, which ſhe turneth backward or any way, with- moving her Head; and ordinarily the one a contrary, or quite dif- nt way from the other.* Dr. *Goddard* in Phil. Tranſ. No. 137.

But what is more extraordinary in this Motion [of the *Cameleon's* ye] *is to ſee one of the Eyes move, whilſt the other remains immove- le; and the one to turn forward, at the ſame time that the other look- behind; the one to look up to the Sky, when the other is fixed on the ound. And theſe Motions to be ſo extreme, that they do carry the upilla under the Creſt which makes the Eye-brow, and ſo far into Canthi, or Corners of the Eyes, that the Sight can diſcern whatever done juſt behind it, and directly before, without turning the Head, hich is faſtened to the Shoulders.* Mem. for a Nat. Hiſt. in Ana- m. Diſſect. at Pariſ. Diſſ. of Camel. pag. 22.

(*k*) *Snails* ſend out their Eyes at a Diſtance, they being con- ined in their four Horns, *like atramentous Spots, fitted to the end their Horns, or rather to the ends of thoſe black Filaments or optick erves, which are ſheathed in her Horns, as* Dr. *Power* wordeth it. bſ. 31. *pag.* 36. So the ingenious Dr. *Liſter*, *Exercit. Anat. chl. & Limac.*

(*l*) *Vid.*

their Eyes are nearly two protuberant Hemiſpheres, and each Hemiſphere often conſiſting of a prodigious Number of other little Segments of a Sphere (*l*). By which Means thoſe Creatures are ſo far from being deny'd any Benefit, of that noble and moſt neceſſary Senſe of Sight, that they have probably more of it than other Creatures, anſwerable to the Rapidity of their Flight, and brisk Motion; and to their Inqueſts after Food, Habitation, or Repoſitories of Generation, or ſuch other Neceſſity of the Animal.

4. Another admirable Proviſion in the Eye, is, its Size; in ſome Animals large, in ſome little. It would be endleſs here to enumerate Particulars; as thoſe of Quadrupeds, Birds, Inſects, and other terreſtrial Animals. And as for Fiſhes, they will fall under another Part of my Survey.

I ſhall therefore only take Notice of its Size in one Creature, the *Mole* (*m*). As the Habitation of

(*l*) *Vid. l.* 8. *c.* 3. *Note* (*a*).

(*m*) *Severinus* is of *Ariſtotel*'s, *Pliny*'s, and *Alb. Magnus*'s Opinion, that the *Mole* hath no Sight; *G. Seger* denies any Humour to be therein, but thinks they may probably ſee, becauſe Nature made nothing in vain. But *Borrichius* ſaith, their Eyes have *appendiculam nerveam in cerebrum euntem, cujus beneficio globuli illi* [the little Eyes] *extra pellem facilè poterant exſeri, retrahique pro arbitrio——In illis oculorum globulis humor aqueus copioſus ſatis natabat; cæterorum non niſi tenue veſtigium.* Blaſ. Anat. Anim. c. 35.

Et quoniam Natura hoc vitæ genus ipſi deſtinavit, etiam perquàm exiguos Oculos——dedit eo conſilio, ut ii, pretioſiſſima corporis pars, à terræ pulvere nè affligerentur. Ii inſuper pilis tecti, &c. Humores illis oculis inſunt, & tunica nigra, uvea, ſe prodit. Ad hos tranſit alio nervus venit. Schneider in Blaſ. ibid.

Some time ſince I made divers accurate Diſſections of the *Eyes* of *Moles*, with the help of Microſcopes, having a doubt whether what we take to be Eyes, were ſuch or no. And upon

at uncouth Animal is wholly ſubterraneous, its odging, its Food, its Exerciſes, nay even all its aſtimes and Pleaſures, are in thoſe ſubterraneous eceſſes and Paſſages, which its own Induſtry hath ade for it ſelf; ſo it is an admirable Proviſion ade in the Size of the Eye of that little Creature, anſwer all its Occaſions, and at the ſame Time prevent Inconveniences. For as a little Light ill ſuffice an Animal living always under Ground, the ſmalleſt Eye will abundantly ſupply that Oc-ion. And as a large protuberant Eye, like that other Animals, would much annoy this Creature its principal Buſineſs, of digging for its Food d Paſſage; ſo it is endowed with a very ſmall e, commodiouſly ſeated in the Head, and well nced and guarded againſt the Annoyances of the rth.

5. Another Thing remarkable in this noble Part Animals, is, its *Numbers*; no leſs than two (*n*) in

on a ſtrict Scrutiny I plainly could diſtinguiſh the *Vitreous* d *Cryſtalline* Humours, yea, the *Ligamentum Ciliare*, and the amentaceous *Mucus*. The *Pupil* I could manifeſtly diſcern be round, and the *Cornea* copped, or conical: The Eye at a great diſtance from the Brain, the Optick Nerve ry ſlender and long, reaching from the Eye through the ermediate Fleſh, and ſo paſſeth to the Brain, along with e pair of Nerves reaching to the Noſe, which are much e largeſt that are in all the Animal. Theſe Creatures, magine, have the Faculty of withdrawing their Eyes, if t quite into the Head, (as *Snails*) yet more or leſs within e Hair, as they have more or leſs Occaſion to uſe or guard eir Eyes.

Galen ſaith, *Moles* have Eyes, the *Cryſtalline* and *Vitreous* Hu-ours, encompaſſed with *Tunicks*. *De Uſ. Part. l.* 14. *c.* 6. o accurate an Anatomiſt was he for his Time.

(*n*) *Pliny* tells us, of a Sort of *Heron* with but one Eye, but was only by Hear-ſay. *Inter Aves Ardeolarum genere, quos Leu-*

cos

in any Inſtance, that I know of; and in ſome Animals more, as I have already hinted (*o*).

Now this is an admirable Proviſion; firſt, for the Convenience of taking in the larger Angle, or Space. And in the next Place, the Animal is by this Proviſion, in ſome Meaſure, prepared for the Misfortune of the Loſs of one of theſe noble, and neceſſary Organs of its Body.

But then beſides all this, there is another Thing conſiderable in this multiplicate Number of the Eyes, and that is, that the Object ſeen is not multiplied as well as the Organ, and appears but one, though ſeen with two or more Eyes (*p*). A manifeſt Sign

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cos vocant, altero oculo carere tradunt. Nat. Hiſt. l. 11. c. 37. the King of the *Nigræ* that hath but one Eye, and that his Forehead. *l.* 6. *c.* 30. Which Fables I take Notice more for the Reader's Diverſion, than any Truth in them.

(*o*) *Suprà*, Note (*i*).

(*p*) The moſt celebrated Anatomiſts differ greatly about the Reaſon, why we ſee not double with two Eyes. The *Galen*, and others after him, generally thought to be from Coalition or Decuſſation of the Optick Nerves, behind the *Os Sphenoïdes*. But whether they decuſſate, coaleſce, or only touch one another, they do not well agree. The *Bartholin* expreſly aſſert, they are united, *Non per ſimplicem contactum interſectionem in hominè, ſed totalem ſubſtantiæ confuſionem.* And l. 3. c. 2. And whereas *Veſalius*, and ſome others, had found ſome Inſtances of their being diſunited; they ſay, *Sed in pariſque ordinarè confunditur interior ſubſtantia, ut accuratâ diſquiſitione deprehendi.*

But our Learned Dr. *Gibſon*, (*Anat. l.* 3. *c.* 10.) ſaith, they *are united by the cloſeſt Conjunction, but not Confuſion of their Fibres.*

But others think the Reaſon is not from any Coaleſcence, Contact, or croſſing of the Optick Nerves, but from a Sympathy between them. This Monſieur *Cartes* is of Opinion, That the *Fibrillæ*, conſtituting the medullary Part of the Nerves, being ſpread in the *Retina* of each Eye, have each of them correſponding Parts in the Brain; ſo that when any of thoſe *Fibrillæ* are ſtruck by any Part of an Image, the

f the infinite Skill of the Contriver of this ſo noble Part, and of the exquiſite Art he employed in the ormation thereof. But the Deſign and Skill of the finite Workman, will beſt be ſet forth by,

6. Surveying the *Parts* and *Mechaniſm* of this mirable Organ the Eye. And here indeed we can- t but ſtand amazed, when we View its admira- ble

reſponding Parts of the Brain are thereby affected, and Soul thereby informed, &c. But ſee more hereafter er Note (*oo*), from *Cartes* himſelf.

Somewhat like this is the Notion of our judicious Dr. *gs*, who thinks the Optick Nerves of each Eye conſiſt of *ologous Fibres*, having their riſe in the *Thalamus Nervorum icorum*, and thence continued to both the *Retinæ*, which made of them: And farther, that thoſe *Fibrillæ* have the e Paralleliſm, Tenſion, &c. in both Eyes; and conſe- ntly when an Image is painted on the ſame correſpond- ſympathizing Parts of each *Retina*, the ſame Effects are duced, the ſame Notice or Information is carried to the *lamus*, and ſo imparted to the Soul, or judging Faculty. at there is ſuch an Ὁμοτοπάθεια between the *Retinæ*, &c. makes very probable, from the enſuing of double Viſion n the Interruption of the Paralleliſm of the Eyes; as en one Eye is depreſſed with the Finger, or their Sympho- interrupted by Diſeaſe, Drunkenneſs, &c. And laſtly, at ſimple Viſion is not made in the former Way, *viz.* by a cuſſation or Conjunction of the Optick Nerves, he proves, auſe thoſe Nerves are but in few Subjects decuſſated, and one conjoined otherwiſe than by a bare Contact, which particularly manifeſt in Fiſhes; and in ſome Inſtances it h been found, that they have been ſeparated without any uble Viſion enſuing thereupon. *Vide Brig. Ophthalmogr.* . 11, & 5. and *Nov. Viſ. Theor. Paſſim.*

What the Opinion of our juſtly eminent Sir *Iſaac Newton* is, y be ſeen in his *Opticks*, Qu. 15. *Are not the Species of Objects with both Eyes, united where the Optick Nerves meet before they e into the Brain, the Fibres on the right Side of both Nerves uniting re*, &c. *For the Optick Nerves of ſuch Animals as look the ſame Way th both Eyes, (as of Men, Dogs, Sheep, Oxen, &c.) meet before they e into the Brain; but the Optick Nerves of ſuch Animals as do not k the ſame Way with both Eyes, (as of Fiſhes, and of the Cameleon) not meet, if I am rightly informed.* Newt. Opt. Q. 15.

ble Fabrick, and conſider the prodigious Exactneſs, and the exquiſite Skill employed in every Part miniſtring to this noble and neceſſary Senſe. To paſs by its Arteries and Veins, and ſuch other Parts common to the reſt of the Body, let us caſt our Eye on its *Muſcles*. Theſe we ſhall find exactly and neatly placed for every Motion of the Eye. Let us view its *Tunicks*, and theſe we ſhall find ſo admirably ſeated, ſo well adapted, and of ſo firm a Texture, as to fit every Place, to anſwer every Occaſion, and to be Proof againſt all common Inconveniences and Annoyances. Let us examine its three *Humours*, and theſe we ſhall find all of exquiſite Clearneſs and Tranſparency, for an eaſy Admiſſion of the Rays; well placed for the refracting of them, and formed (particularly the *Cryſtalline Humour*) by the niceſt Laws of Opticks, to collect the wandring Rays into a Point. And to name no more, let us look into its darkned Cell, where thoſe curious Humours lie, and into which the Glories of the Heavens and the Earth are brought, and exquiſitely pictured; and this Cell we ſhall find, without, well prepared by Means of its Texture, Aperture, and Colour, to fence off all the uſeleſs or noxious Rays; and within, as well coated with a dark Tegument, that it may not reflect, diſſipate, or any way confuſe or diſturb the beneficial Rays (*q*).

But

(*q*) *Nigra eſt* [Uvea] *ut radios* (*ab Oculi fundo ad anteriorem ejus partem reflexos*) *obumbret; nè hi* (*ut ait clar. Carteſius*) *ad Oculi fundum retorti ibidem confuſam viſionem efficerent. Alia forſan ratio hujus nigredinis ſtatuatur, quòd radii in viſione ſuperflui, qui ab objectis lateralibus proveniunt hoc ritu abſorbeantur. Ità enim è loco obſcuro interdiu objecta optimè intuemur, quia radii tunc temporis circumfuſi lumine non diluuntur.* Brigg's Ophthal. c. 3. ſect. 5.

(*r*) *Admi-*

But to deſcend to Particulars, although it would be a great Demonſtration of the Glory of God, yet would take up too much Time, and hath been in ſome Meaſure done by others that have written of God's Works. Paſſing over therefore what they have obſerved, I ſhall under each principal Part take a tranſient Notice of ſome Things they have omitted, or but ſlightly ſpoken of.

And my firſt Remark ſhall be concerning the *Muſcles* of the Eye, and their Equilibration. Nothing can be more manifeſtly an Act of Contrivance and Deſign, than the *Muſcles* of the Eye, admirably adapted to move it any, and every way; upwards, downwards, to this Side or that, or howſoever we pleaſe, or there is Occaſion for, ſo as to always keep that Paralleliſm of the Eye, which is neceſſary to true Viſion. For the Performance of which Service, the Form, the Poſition, and the due Strength of each Muſcle is admirable. And here might Inſtance the peculiar and artificial Structure of the *Trochlearis*, and the Augmentation of its Power by the *Trochlea* (*r*); the Magnitude and Strength of the *Attollent Muſcle*, ſomewhat exceeding that of its Antagoniſt; the peculiar Muſcle, called

(*r*) *Admirandum Dei artificium ex diverſorum animalium comparatione indies evadit manifeſtius. Mirantur omnes Trochlearem in oculis Hominum & Quadrupedum, & quidem jure: ſed admirationem omnem ſuperat, quòd ſine Trochleâ oculum movens, in Avibus novum genus Trochleæ longè artificioſius Nictitandi Membranæ dederit.* Blaſ. de anat. Animal. p. 2. c. 4. *ex Stenon.*

[Muſculum Trochlearem] *per intermedium trochleam traducentem, nunquam intueor, quin admirabundus mecum,* Ὁ Θεὸς, *exclamem,* οὐ μόνον ἀεὶ γεωμετρεῖ, ἀλλὰ καὶ ἀεὶ μηχανᾶται. *I. C. Sturmii Exercit. Acad. 9. de Viſ. Org. & Rat. c. 3. ſect. 4. p. 446.*

called the *Seventh*, or *Suſpenſory Muſcle* (*s*), given to Brutes, by reaſon of the prone Poſture of their Bodies, and frequent Occaſions to hang down their Heads: And I might ſpeak alſo of the peculiar Origin and Inſertion of the *lower Oblique Muſcle* (*t*), which is very notable, and many other Things relating to theſe Parts; but it would be tedious to deſcend too much to thoſe admirable Particulars. And therefore to cloſe up theſe Remarks, all I ſhall farther take Notice of, ſhall be only the exquiſite Equilibration of all theſe *Oppoſite* and *Antagoniſti* *Muſcles*

(*s*) *Obſervare eſt quod Quadrupedes, qui oculos in terram prono pendulos gerunt, Muſculum peculiarem habent, quo Oculi globus ſuſpenditur——Hoc Muſculo Bos, Equus, Ovis, Lepus, Porcus, &c. præſunt: hoc etiam Canis inſtruitur, ſed alio modo conformatum habet.* Willis de An. Brut. p. 1. c. 15.

Of this Opinion alſo was *Bartholine*, *Anat. l.* 3. *c.* 8. and divers other eminent Anatomiſts.

But Dr. *Briggs* is of Opinion that the *Adnata*, and the other Muſcles ſufficiently anſwer all thoſe Ends aſcribed to this Muſcle by former Anatomiſts, and thinks *Probabilius itaque eſſe hunc Muſculum nervi Optici actionem (per vices) confirmare, ne prono Brutorum inceſſu & copioſo affluxu humorum debiliretur.* Ophthal. c. 2. ſect. 2.

The *Muſculus Suſpenſorius* being in the *Porpeſs*, as well as Brutes, Dr. *Tyſon* thinks the Uſe of it is not to ſuſpend the Bulk of the Eye; but rather by its equal Contraction of the *Solerotis*, to render the Ball of the Eye more or leſs Spherical, and ſo fitter for Viſion. *Tyſon's Anat. of the Porpeſs, p.* 39.

(*t*) *Muſculus obliquus inferior oritur à peculiari quodam foramine in latere Orbitæ ocularis facto, (contra quàm in cæteris, &c.) quo fit ut ex unâ parte à Muſculo trochleari, ex alterâ verò ab hujus Muſculi commodiſſimâ poſitione, Oculus in æquilibrio quodam conſtitutus, irretortus obtutu verſus objecta feratur, nec plus juſto accedat verſus internum externumve canthum; quæ quidem Libratio omnino nulla fuiſſet, abſque hujus Maſculi peculiari originatione (cujus ratio omnes hucuſque Anatomicos latuit.)* And ſo this curious Anatomiſt goes on to ſhew farther the ſtupendous Artifice of the Great Creator in this Poſition of the *Oblique Muſcles*. *Brigg's Nova Viſ. Theor. p.* 11. *meo libro.*

(*u*) Beſides

Muſcles, affected partly by the Equality of the ſtrength; which is the Caſe of the *Adducent* and *Abducent Muſcles*; partly by their peculiar Origin, or the Addition of the *Trochlea*, which is the Caſe of the *Oblique Muſcles* (*u*); and partly by the natural Poſture of the Body, and the Eye, which is the Caſe of the *Attollent* and *Depriment Muſcles*. By this ſo curious and exact a Libration, not only unſeemly Contortions, and incommodious Vagations of the Eye are prevented, but alſo it is able with great Readineſs and Exactneſs to apply it ſelf to every Object.

As to the *Tunicks* of the Eye, many Things might be taken notice of, the prodigious Fineneſs of the *Arachnoides*, the acute Senſe of the *Retina*, the delicate Tranſparency of the *Cornea* (*w*), and the firm and ſtrong Texture of that and the *Sclerotica* too; and each of them, in theſe and every other reſpect, in the moſt accurate Manner adapted to the Place in which it is, and the Buſineſs it is there to perform.

(*u*) Beſides thoſe particular Motions which the Eye receives from the *Oblique Muſcles*, and I may add its Libration alſo in ſome Meaſure, ſome Anatomiſts aſcribe another not leſs conſiderable Uſe to them; namely, to lengthen and ſhorten the Eye (by ſqueezing and compreſſing it) to make it correſpond to the Diſtances of all Objects, according as they are nigh or far off. Thus the ingenious Dr. *Keil*; *The Aqueous Humour being the thinneſt and moſt liquid, eaſily changeth its Figure, when either the* Ligamentum Ciliare *contracts, or both the* Oblique Muſcles *ſqueeze the middle of the Ball of the Eye, to render it Oblong when Objects are too near us.* Keil's Anat. Chap. 4. Sect. 4. See *Note* (*y*).

(*w*) *Quis verò opifex præter Naturam, quâ nihil poteſt eſſe callidius, tantam ſolertiam perſequi potuiſſet in Senſibus? quæ primùm Oculos membranis tenuiſſimis veſtivit, & ſepſit; quas primam perlucidas fecit, ut per eas cerni poſſet: firmas autem, ut continerentur.* Cic. de Nat. Deor. l. 2. c. 57.

perform, But for a Sample, I ſhall only take Notice of that Part of the *Uvea* which makes the *Pupil*. It hath been obſerved by others, particularly by our Honourable Founder (*x*), That as we are forced to uſe various Apertures to our Optick Glaſſes, ſo Nature hath made a far more compleat Proviſion in the Eyes of Animals, to ſhut out too much, and to admit ſufficient Light, by the Dilatation and Contraction of the Pupil (*y*). But it deſerveth our eſpecial Remark, that theſe Pupils are in divers Animals of divers Forms, according to their peculiar Occaſions. In ſome (particulary in Man) it is round; that being the moſt proper Figure for the Poſition of our Eyes, and the Uſe we make of them both by Day and Night. In ſome other Animals, it is of a longiſh Form; in ſome Tranſverſe (*z*), with its Aperture large, which is an admirable

(*x*) *Boyle* of *Final Cauſes*.

(*y*) It is eaſy to be obſerved, that the *Pupil* openeth in dark Places; as alſo when we look at far diſtant Objects, but contracts by an Increaſe of Light, and when the Objects are nigh. This Motion of the *Pupil* ſome ſay, is effected by the circular and ſtrait Fibres of the *Uvea*, and ſome attribute it to the *Ligamentum Ciliare*. Yet I have no great doubt but that they both concur in that Action, and that the *Ligamentum Ciliare* doth, at the ſame Time the Pupil opens or ſhuts, dilate or compreſs the *Cryſtalline*, and bring it nigher unto, or carry it farther off the *Retina*. For the Structure of the *Ligamentum Ciliare*, and its two Sorts of Fibres, drawn with the Help of a Microſcope, I ſhall refer to Mr. *Cowper's Anat. T.* 11.

(*z*) *In Bove, Caprâ, Equo, Ove, & quibuſdam aliis elliptica eſt* (Pupilla) *ut eo magis in hiſce forſan animalibus, quæ prono inceſſu victum in agris quæritant, radios laterales ad mala & incommoda utrinque devitanda admittat.* Briggs's Opthal. c. 7. ſect. 6.

Homini erecto, aliiſque, &c. caput erigere, & quaquaverſus circumſpicere ſolitis, plurima ſimul objecta, tum ſuprà, tum infrà, tum è latere utroque——viſu excipiuntur; quapropter Oculi Pupilla rotunda eſſe debet.——Attamen bovi, &c. caput ferè ſemper provum——gerentibus, tantum

mirable Proviſion for ſuch Creatures to ſee the better laterally, and thereby avoid Inconveniencies, as well as help them to gather their Food on the Ground, both by Day and Night. In other Animals the Fiſſure of the Pupil is erect (*aa*), and alſo capable of opening wide, and ſhutting up cloſe. The latter of which ſerves to exclude the brighter Light of the Day, and the former to take in the more faint Rays of the Night, thereby enabling thoſe Nocturnal Animals (in whom generally this erect Form of the Pupil is) to catch their Prey with the greater Facility in the Dark (*bb*), to ſee upwards and downwards, to climb, *&c.* Thus much for the *Tunicks.* The

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ntùm quæ coràm, & paulo à latere obverſantur, intuitu opus eſt: propter Pupilla——oblonga eſt, &c. Willis de Anim. Brut. P. I. C. 15.

(*aa*) Thus *Cats* (their Pupils being erect, and the ſhutting of their Eye-lids tranſverſe thereunto) can ſo cloſe their Pupil, as to admit of, as it were, one only ſingle Ray of Light; and by throwing all open, they can take in all the faineſt Rays. Which is an incomparable Proviſion for theſe Animals, that have Occaſion to watch and way-lay their Prey both by Day and Night.

(*bb*) There is beſides this large opening of the Pupil, in ſome Nocturnal Animals, another admirable Proviſion, enabling them to catch their Prey in the Dark; and that is a Radiation of the Eyes: Of which Dr. *Willis* thus; *Hujus uſus eſt Oculi Pupillam, quaſi jubare inſito, illuminare, ut res noctu, & in tenebris poſitas conſpicere valeat: quare in Fele plurimùm illuſtris eſt: at Homini, Avibus & Piſcibus deeſt.* This Illumination he ſpeaks of, is from the *Tapetum*, in the Bottom of the Eye, or the ſhining of the *Retina*, round the Optick Nerve.

Beſides which, he ſaith, the *Iris* hath a Faculty alſo, in ſome, of darting out Rays of Light, ſo as to enable them to ſee in the Dark: Of which he tells this Story; *Novi quendam cerebro calidiori præditum, qui poſt uberiorem vini generoſi potum in nocte atratâ, ſive tenebris profundis, literas diſtinctè legere potuit. Cujus ratio videtur eſſe, quòd ſpiritus animales velut accenſi, adeòque ab hâc fride irradiantes, jubare inſito Medium illuminabant.* Willis Ibid.

The next Thing I shall take Notice of, will relate to the *Humours* of the Eye, and that only concerning the Mechanism of the *Crystalline Humour*; not its incomparable Transparency; nor its exact lenticular Form; nor its curious araneous Membrance (*cc*), that constringeth and dilateth it, and

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Such another Thing, *Pliny* tells us, was reported of Tiberius *Cæsar*; *Ferunt Tib. Cæs. nec alii genitorum mortalium, fuisse naturam ut expergefactus noctu paulisper, haud alio modo quam luce clarâ, contueretur omnia.* Nat. Hist. l. 11. c. 37.

So Dr. *Briggs*; *Virum sanè calidæ indolis novi in Comitatu Bedfordiensi degentem, qui oculis felineis——donatus est: adeo ut epistolam ——mire admodum in loco obscuro (ubi eadem mihi vix apparuit) perlegit. Hujus vero Oculi (nisi quod Pupillas insigniores obtinuerint) aleorum formatione neutiquam discrepabant.* Ophthal. c. 5. sect. 11.

(*cc*) The *Tunica Aranea* is taken Notice of by Friar Bacon, who calls it, *Tela Aranea*, and saith, *in hâc continetur——glacies vel Crystallinum.* Rog. Bacon's Perspect. Distinct. 2. c. 3. The wrinkling of this, and the *Cornea* (as the Skin is of old Persons) he thinks is the Cause of the Obscurity of the Sight in such Persons. *Bacon Ib. par.* 2. *c.* 2. But this *Tunick* some deny, and others allow of; Dr. *A. M.* of *Trinity-College, Dublin*, (in his *Relat. of Anat. Obs.* in the Eyes of Animals, in a Letter to Mr. Boyle, *Ann.* 1682. annexed to his *Anat. Account of the Elephant burnt in* Dublin, p. 57.) affirms the *Tunica Aranea*, and saith, *I have often seen it before 'twas exposed to the Air one Minute, notwithstanding what Dr.* Briggs *saith to the contrary*, &c. But Dr. Briggs his Opinion is, *Humor Crystallinus, nisi aeri diutius expositus, vel leniter coctus (instar lactis) cuticulam non acquirit: quæ vero impropriè Tunica Aranea dicitur, cum si tantum adventitia, ut in Oculo Bovis recens execto appareat.* Briggs's Opthalm. c. 3.

The *Crystalline Humour* being of a double Substance, outwardly like a Jelly, towards the Centre as consistent as hard Suet, upon occasion whereof its Figure may be varied; which Variation may be made by the *Ligamentum Ciliare*; Dr. Grew doth, upon these Accounts, not doubt to ascribe to the *Ligamentum Ciliare*, a Power of making the *Crystalline* more Convex, as well as of moving it to, or from the *Retina*. See *Grew's Cosmolog. Sacr. l.* 1. *c.* 4. Now it is certain by the Laws of Opticks, that somewhat of this is absolutely necessary to distinct Vision, inasmuch as the Rays proceeding from nigh Objects do more diverge, and those from distant Objects less;

varieth its *Focus*, (if any ſuch Variation there be, ſome affirm with great Probability,) nor laſtly, admirable Approach to or from the *Retina*, by elp of the *Ciliar Ligament* (*dd*), according as Objects

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ſs: Which requires either that the *Cryſtalline Humour* ſhould made more Convex, or more flat; or elſe an Elongation, ſhortning of the Eye, or of the Diſtance between the *Cryalline Humour* and the *Retina*.

But although Dr. *Briggs* (ſo good a Judge) denies the *Tuca Cryſtallina*, contrary to the Opinion of moſt former Anamiſts; yet there is great Reaſon to conclude he was in a iſtake, in my Opinion, from the Obſervations of the *French natomiſts*, of the *Cryſtalline* of the Eye, of the *Gemp* or *Chamois*, o ſay, The *Membrana Arachnoïdes was very thick, and hard, ſo t it was eaſily ſeparated from the Cryſtallinus*, p. 145.

The ſame Anatomiſts alſo favour the Surmiſe of Dr. *Grew*. is [Contraction of the Fibres of the *Ligamentum Ciliare* on e ſide, and Dilatation on the other] *would make us think that ſe Fibres of the* Ligamentum Ciliare, *are capable of Contraction, voluntary Dilatation, like that of the Fibres of the Muſcles; and t this Action may augment, or diminiſh the Convexity of the* Cryllinus, *according as the Need which the Diſtance of the Objects may ke it to have on the Eye, to ſee more clearly and diſtinctly.* Anat. ſcrip. of a *Bear*, p. 49.

Since my penning the foregoing Notes, having as critically I could, diſſected many Eyes of Birds, Beaſts and Fiſhes, manifeſtly found the *Membrana Arachnoïdes*, and will undertke to ſhew it any one, with great Eaſe and Certainty. It indeed ſo tranſparent, as not to be ſeen diſtinct from the *ſtalline*. But if the *Cornea* and *Uvea* be taken off before, the *vitreous Humour* behind it, and the out-ſide of the *Cryalline* be gently cut, the *Arachnoïdes* may be ſeen to open, and e *Cryſtalline* will eaſily leap out, and part from the *Ligantum Ciliare*; which otherwiſe it would not do: For it is the *Arachnoïdes* braced to the *Ligamentum Ciliare*. This embrane or Tunick, in the Ox, is ſo ſubſtantial and ſtrong, ough thin, that it yields to, or ſinks under the ſharpeſt Lant, and requires (for ſo thin and weak a Membrane in Aparance) a ſtrong Preſſure to pierce it.

(*dd*) As Birds and Fiſhes are in divers Things conformable, in ſome Sort they are in their Eye; to enable it to correond to all the Convergences, and Divergences of the Rays, which

Objects are far off or near, because these Things are what are usually taken notice of; but that which I shall

which the Variations of each of the Mediums may produce. For this Service the *Tunica Choroeides*, (in Fishes) hath a muscu-culous Substance at the Bottom of it, lying round the Optick Nerve, at a small Distance from it; by which Means I imagine they are able to contract, and dilate the *Choroeides*, and thereby to lengthen and shorten the Eye: For the helping to which Service, I imagine it is that the *Choroeides*, and *Sclerotica* are in a great Measure parted, that the *Choroeides* may have the greater Liberty of acting upon the Humours within.

But in Birds, I have my self found, that although the *Choroeides* be parted from the *Sclerotica*; yet the *Choroeides* hath no Muscle, but instead thereof, a curious pectinated Work, seated on the Optick Nerve, represented in *Fig.* 2. In which *c. d. b. d.* represents the *Choroeides* and *Sclerotica*; *a. b.* the Part of the *Optick Nerve*, that is within the Eye; *v. v. v.* the *vitreous Humour*; *a. f. g. b.* the *Pecten*; *b. i.* the *Crystalline*. For the Reception of this *Pecten*, the *Optick Nerve* comes farther within in the Eye, than in other Creatures. The Structure of the *Pecten*, is very like that of the *Ligamentum Ciliare*; and in the Eye of a *Magpye*, and some others, I could perceive it to be musculous towards the Bottom. This *Pecten* is so firmly fixed unto, or embodied in the *vitreous Humour*, that the *vitreous Humour* hangs firmly to it, and is not so easily parted from it. By which Means all the Motions of the *Pecten* are easily communicated to the *vitreous Humour*, and indeed to all contained in the *Choroeides*. And forasmuch as the *Crystalline* is connected to the *vitreous Humour*, therefore also the Alteration in the *vitreous Humour* affect also the *Crystalline*; and the *Crystalline* is hereby brought nearer unto, or farther from the *Retina*, as Occasion is.

Besides all which Observables in the *Choroeides*, and into the Eye, I have also found this farther remarkable in the *Sclerotica* and outer-part of the Eye of Birds, *viz.* That the fore-part of the *Sclerotica* is horny and hard, the middle-part thin and flexible, and *Braces* intervene between the fore and hind-part, running between the *Choroeides* and *Sclerotica*; by which Means the *Cornea*, and back-part of the Eye, are brought to the same Conformity, that the rest of the Eye hath.

The great End and Design of this singular and curious *Apparatus* in the Eyes, both of Birds and Fishes, I take to be 1. To enable those Creatures too see at all Distances, far off

ſhall obſerve is, the prodigious Art and Finery
f its conſtituent Parts, it being, according to ſome
te nice Microſcopical Obſervations (*ee*), compoſed
divers thin Scales, and theſe made up of one
ſingle

nigh; which (eſpecially in the Waters) requireth a diffe-
nt Conformation of the Eye. In Birds alſo, this is of great
ſe, to enable them to ſee their Food at their Bill's End, or
reach the utmoſt Diſtances their high Flights enable them
view; as to ſee over great Tracts of Sea or Land, whither
ey have Occaſion to fly; or to ſee their Food or Prey, even
all Fiſhes in the Waters, and Birds, Worms, &c. on the
rth, when they ſit upon Trees, high Rocks, or are hovering
h in the Air. 2. To enable thoſe Animals to adapt their
e to all the various Refractions of their *Medium*. Even
Air it ſelf varies the Refractions, according as it is rarer
denſer, more or leſs compreſſed; as is manifeſt from the
rned and ingenious Mr. *Lowthorp*'s Experiment in *Phil.*
anſ. No. 257. and ſome other Experiments ſince of the
fore-commended Mr. *Hawksbee*, both in natural, rarify'd
compreſſed Air; in each of which, the Refractions con-
ntly varied in exact Proportion to the Rarity or Denſity
the Air. *Vid. Hawksbee's Exp. p.* 175, &c.

Beſides this Conformity in general, between the Eyes of
rds and Fiſhes, *Du Hamel* tells us of a ſingular Conformity
the *Cormorant*'s Eye, and that is, that the *Cryſtalline* is globous,
n Fiſhes, to enable it to ſee and purſue its Prey under Wa-
: Which *J. Faber*, in Mr. *Willughby* ſaith, they do *with won-*
ful Swiftneſs, and for a long Time, Will. Ornithol. p. 329.

(*ee*) The *Cryſtalline Humour*, when dry'd, doth manifeſtly
ough appear to be made up of many very thin ſpherical
mina, or Scales lying one upon another. Mr. *Lewenhoek*
ckons there may be two thouſand of them in one *Cryſtalline*,
m the outermoſt to the Centre. Every one of theſe Scales,
ſaith, he hath diſcovered to be made up of one ſingle Fi-
e, or fineſt Thread wound, in a moſt ſtupendous Manner,
is Way, and that Way, ſo as to run ſeveral Courſes, and meet
as many Centres, and yet not to interfere, or croſs one a-
ther, in any one Place. In *Oxen*, *Sheep*, *Hogs*, *Dogs* and *Cats*,
e Thread ſpreads into three ſeveral Courſes, and makes as
any Centres: In *Whales* five; but in *Hares* and *Rabbets* only
o. In the whole Surface of an *Ox*'s *Cryſtalline*, he reckons
ere are more than twelve thouſand Fibres juxtapoſited.
or the right and clear Underſtanding of the Manner of
which

ſingle minuteſt Thread or Fibre, wound round and round, ſo as not to croſs one another in any one Place, and yet to meet, ſome in two, and ſome in more different Centres; a Web not to be woven by an *Optick Lens*, not to be wrought by any Art leſs than Infinite Wiſdom.

Laſtly, To conclude the Parts of this admirable Organ, I ſhall make only one Remark more, and that is about its *Nerves*. And here, among others, the admirable Make of the *Optick Nerves* might deſerve to be taken Notice of in the firſt Place, their *Medullary* Part (*ff*) terminating in the Brain itſelf, the Teguments propagated from the *Meninges*, and terminating in the Coats of the Eye, and their commodious inſertions into the Ball of the Eye, in ſome directly oppoſite to the Pupil of the Eye, in others obliquely towards one Side (*gg*). But moſt of theſe Things have been treated of, and the Conveniency hereof ſet forth by others that have written of

God's

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which admirable Piece of Mechaniſm, I ſhall refer to his Cuts and Deſcriptions in *Philoſ. Tranſ.* No. 165, and 193. The Truth hereof I have heard ſome ingenious Men queſtion; but it is what I my ſelf have ſeen, and can ſhew to any Body with the Help of a good Microſcope.

(*ff*) *S. Malpighi* obſerved the Middle of the *Optick Nerve* of the *Sword-Fiſh*, to be nothing elſe but a large Membrane folded according to its Length in many Doubles, almoſt like a Fan, and inveſted by the *Dura Mater*; whereas in Land Animals it is a Bundle of Fibres. *Vide Philoſ. Tranſ.* No. 27.

(*gg*) *Certiſſimum eſt, quòd in omnibus Oculis humanis (quos ſatis mihi diſſecare contigit) Nervus opticus Pupillæ è diametro opponitur,* &c. Brigg's Opthal. cap. 3. ſect. 15. Ita *Willis de Anim. de Brut.* p. 1. c. 15.

Nervi Optici in nobis, item in Cane, Fele (& in cæteris forſan animalibus calidis) ad fundum Oculi delati Papillæ regioni proſpiciunt, dum interim in aliis Quadrupedibus, uti etiam in Piſcibus & Volucribus, obliquè ſemper Tunicæ Sclerotidi inſeruntur. Unde, Willis Ib. cap. 7. ſect. 11.

(*hh*) This

od's Works. I ſhall therefore take Notice only of ae Wiſe Proviſion the Creator hath made about the lotion of the Eye, by uniting into one the *Third air* of Nerves, called the *Motory Nerves* (*hh*), ch of which ſending its Branches into each Muſcle each Eye, would cauſe a Diſtortion in the Eyes; t being united into one, near their Inſertion into e Brain, do thereby cauſe both Eyes to have the me Motion; ſo that when one Eye is moved this ay and that Way, to this and that Object, the her Eye is turned the ſame Way alſo.

Thus from this tranſient and ſlight View (I may ll it) of the Parts of the Eye, it appears what an mirable Artiſt was the Contriver thereof. And w in the

Seventh and laſt Place, let us conſider what Proion this Admirable Artiſt hath made for the *Guard* d *Security* of this ſo well formed Organ (*ii*). And here

(*hh*) *This Pair is united at its Riſe; whence is commonly drawn a aſon why one Eye being mov'd towards an Object, the other is directed to the ſame.* Gibſon's Anat. *Book* III. *Chap.* 11. So *Bartho- Anat.* Libellus 3. cap. 2.

(*ii*) Among all the other Security the Eye hath, we may kon the Reparation of the *Aqueous Humour*; by which eans the Eye when wounded, and that in all Appearance ry dangerouſly too, doth often recover its Sight: Of which rn. *Verzaſcha* gives divers Examples Ancient and Modern. he is from *Galen*, of a Boy ſo wounded, that the *Cornea* fell, d became flaccid, but yet recovered his Sight. Other ſuch e Inſtances alſo he gives from *Realdus Columbus*, *Rhodius*, and lpius; and one that he cured himſelf in theſe Words; *Ego Nobiliſſimi viri filiolâ ſimilem cauſam obſervavi: hæc dum levibus de ſis cum fratre altercaret, iſte iracundiâ percitus cultellum Scriptorium prehendit, & ſororis oculo vulnus inſligit, inde humor aqueus ef- xit. Vocatus præſentem Chirurgum juſſi ſequens collyrium anodynum exſiccans tepidè ſæpius admovere.* Receipe *aq. Plantag. Quatuor nc. Roſar. Sanicul. Euphraſ.* ana *Trochiſc. alb. Rhaſ. cum Opio*

duo.

here we ſhall find the Guard equivalent to the Uſe and Excellency of the Part. The whole Organ fortified and fenced with ſtrong, compact Bones, lodged in a ſtrong, well made Socket, and the Eye itſelf guarded with a nice made Cover (*kk*). Its Humours, and its inward Tunicks, are indeed tender, proportion-

dua Scrup. Tutiæ pp. un. Scrup. Croci orent. ½ Scrup. M. Hoc Collyrium inflammationem compeſcuit, vulnus ſiccavit & ſanavit. Hinc poſt aliquot menſes Humor aqueus ſuccrevit. Nam viſus, ſed dibilior, cum ſummo parentum gaudio redivit. B. Verzaſchæ Obſerv. Medicæ. Obſ. 14.

Another Cure of this Kind, was experimented by Dr. *Daniel Major*, upon a Gooſe, *Ann.* 1670. the *Aqueous Humour* of both whoſe Eyes they let out, ſo that the Eyes fell, and the Gooſe became quite Blind: But without the Uſe of any Medicine, in about two Days Time, Nature repaired the watery Humour again, the Eyes returned to their former Turgency, and the Gooſe was in a Week after produced Seeing before twenty eight or thirty Spectators. *Ephem. Germ. T.* 1. *Add. ad Obſ.* 11.

From the ſame Cauſe, I doubt not, it was that the Eyes of a Gentleman's Daughter, and thoſe of a Cock, when wounded, ſo that the *Cornea* ſunk, were reſtored by a *Lithuanian* Chymiſt, that paſſed for a Conjurer, by the Uſe of a Liquor found in *May*, in the Veſiculæ of *Elm*. Of which ſee Mr. *Reyſ. Catal. Cantab.* in *Ulmus* from *Henr. ab Heers.*

(*kk*) *Palpebræ, quæ ſunt tegumenta Oculorum, molliſſimæ tactu, ne læderent aciem, aptiſſimæ factæ, & ad claudendas Pupilias, nè quid incideret, & ad aperiendas; idque providit, ut identidem fieri poſſet celeritate maximâ celeritate. Munitæque ſunt Palpebræ tanquam vallo pilorum, quibus & apertis Oculis, ſi quid incideret, repelleretur, & ſomno conniventibus, cum Oculis ad cernendum non egerimus, ut qui, tanquam involuti, quieſcerent. Latent præterea utiliter, & excelſis undique partibus ſepiuntur. Primum enim ſuperiora Supercilliis obducta ſubterrem a capite, & fronte defluentem repellunt. Genæ deinde ab inferiore parte tutantur ſubjectæ, leviterque eminentes.* Cicer. de Nat. Deor. l. 2. c. 57.

Tully, in the Perſon of a *Stoick*, having ſo well accounted for the Uſe of the *Eye-Lids*, I ſhall for a further Manifeſtation of the Creator's Contrivance and Structure of them, take Notice of two or three Things: 1. They conſiſt of a thin and flexible, but ſtrong Skin, by which Means they the better wipe, clean, and guard the *Cornea*. 2. Their Edges are forti-

fied

oportionate to their tender, curious Uſes; but
e Coats without, are context and callous, firm
d ſtrong. And in ſome Animals, particularly
Birds

H with a ſoft *Cartilage*, by which Means they are not only
abled the better to do their Office, but alſo to cloſe and
t the better. 3. Out of theſe Cartilages grow a Palliſade
tiff Hairs, of great Uſe to warn the Eye of the Invaſion
Dangers, to keep off Motes, and to ſhut out too exceſſive
ght, &c. and at the ſame time to admit of (through their
ervals) a ſufficient Paſſage for Objects to approach the Eye.
d it is remarkable, That theſe Hairs grow but to a certain,
nmodious Length, and need no Cutting, as many other
irs of the Body do: Alſo, That their Points ſtand out of
Way, and in the Upper-lid bend upwards, as they do
vnwards in the Lower-lid, whereby they are well adapted
heir Uſe. From which laſt Obſervables, we may learn
v critical and nice the great Author of Nature hath been,
even the leaſt and moſt trivial Conveniences belonging to
imal Bodies; for which Reaſon I have added it to *Tully's*
marks. And more might have been added too, as particu-
y concerning the curious Structure and Lodgment of the
ht *Muſcle*, which opens the Eye-lids; and the *Orbicularis*,
Circular one, that ſhuts them; the nice *Apparatus* of
nds that keep the Eye moiſt, and ſerve for *Tears*; together
h the Reaſon why Man alone, who is a Social Animal,
h exhibit his Social Affections by ſuch outward Tokens as
rs; the *Nerves* alſo, and other Organs acting in this Mini-
y. I might alſo ſpeak of the Paſſages for diſcharging the
erfluous Moiſture of the Eyes through the Noſtrils, and
ch more of the like Kind. But it would take up too much
om in theſe Notes; and therefore it ſhall ſuffice to give
y ſuch Hints as may create a Suſpicion of a noble OEcono-
and Contrivance in this (I had almoſt ſaid) leaſt conſider-
e Part of the Eye. But for Particulars I ſhall refer to the
natomiſts; and for ſome of theſe Things, particularly to
. *Willis's Cereb. Anat.* and *de Anim. Brut.* and Mr. *Cowper's*
egant Cuts in the 11th *Tab.* of his *Anatomy*.

To the Eye-lids we may add another Guard afforded the
es of moſt Quadrupeds, Birds, and Fiſhes, by the *Nictita-*
g-Membrane, which Dr. *Willis* gives this Account of, *Pluri-*
s [Animalibus] *quibus Muſculus ſuſpenſorius adeſt* (which
mitation he need not to have added) *etiam alter Membra-*
us conceditur, qui juxta interiorem oculi canthum ſitus, quando ele-

vatur

Birds (*ll*), ſome Part of thoſe Tunicles have the Nature and Hardneſs of Bone or Horn.

But for Creatures, whoſe Eyes, like the reſt of their Body, are tender, and without the Guard of Bones; there Nature hath provided for this neceſſary and tender Senſe, a wonderful kind of Guard by endowing the Creature with a Faculty of withdrawing its Eyes into its Head (*mm*), and lodging them in the ſame Safety with the Body.

Thus have I ſurvey'd this firſt Senſe of Animals, I may ſay, in a curſory, not accurate, ſtrict Manner, co-

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vatur, Oculi globum fere totum obtegit. Hujus uſus eſſe videtur, cum Beſtiæ inter gramina, &c. capita ſua propter victum capeſſendum demergunt, hic Muſculus Oculi Pupillam, nè à ſtipularum incurſu ſollicitatur, oculit, munitque. De Anim. Brut. p. 1. c. 15.

This Membrane Man hath not, he having little Occaſion to thruſt his Head into ſuch Places of Annoyance, as Beaſts and other Animals; or if he hath, he can defend his Eyes with his Hands. But Birds (who frequent Trees and Buſhes) and Quadrupeds, (Hedges and long Graſs) and who have no Part ready, like the Hand, to fence off Annoyances; theſe, I ſay, have this incomparable Proviſion made for the Safety of their Eyes. And for Fiſhes, as they are deſtitute of Eye-Lids, becauſe in the Waters there is no Occaſion for a Defenſative againſt Duſt and Motes, offenſive to the Eyes of Land-Animals, not to moiſten and wipe the Eyes, as the Eye-Lids do, ſo the *Nictitating-Membrane* is an abundant Proviſion for all their Occaſions, without the Addition of the Eye-Lids.

And now, if we reflect, are theſe the Works of any Thing but a Wiſe and Indulgent Agent?

(*ll*) Although the Hardneſs and Firmneſs of the *Adnata* or *Sclerotica* in Birds, is a good Guard to their Eyes, yet I do not think it is made thus, ſo much for a Defence, as to miniſter to the lengthning and ſhortning the Eye, mentioned before in *Note* (*cc*).

(*mm*) *Cochleis oculorum vicem Cornicula bina prætentu implent.* Plin. Nat. Hiſt. l. 11. c. 37. See more of the Eyes of *Snails* before in *Note* (*k*); and in *Note* (*l*), I ſaid that I ſuſpected *Moles* alſo might thruſt out, or withdraw their Eyes more or leſs within the Hair or Skin. (*nn*) The

onſidering the prodigious Workmanſhip thereof; ut ſo, as abundantly to demonſtrate it to be the Contrivance, the Work of no leſs a Being than the nfinite Wiſe, Potent, and Indulgent Creator (*nn*): or none leſs could compoſe ſo admirable an Or- an, ſo adapt all its Parts, ſo adjuſt it to all Occa- ons, ſo nicely provide for every Uſe, and for every mergency: In a Word, none leſs than GOD could, ſay, thus contrive, order, and provide an Organ, magnificent and curious as the Senſe is uſeful; a enſe without which, as all the Animal World would in perpetual Darkneſs, ſo it would labour under rpetual Inconveniencies, be expoſed to perpetual arms, and ſuffer perpetual Wants and Diſtreſſes. t now by this admirable Senſe, the great GOD, ho hath placed us in this World, hath as well pro- ded for our comfortable Reſidence in it; enabled to ſee and chuſe wholſome, yea, delicate Food; provide our ſelves uſeful, yea, gaudy Cloathing, d commodious Places of Habitation and Retreat. e can now diſpatch our Affairs with Alacrity and eaſure, go here and there as our Occaſions call us. e can, if need be, ranſack the whole Globe, pe- trate into the Bowels of the Earth, deſcend to e Bottom of the Deep, travel to the fartheſt Re- ons of this World, to acquire Wealth, to encreaſe r Knowledge, or even only to pleaſe our Eye and Fancy.

(*nn*) The diligent *Sturmius* was fully perſwaded there could t be any ſpeculative Atheiſm in any one that ſhould well rvey the Eye. *Nobis*, ſaith he, *fuit perſuaſiſſimum, Atheiſ- um, quem vocant ſpeculativum, h. e. obſirmatam de Deitate in Uni- rſo nullâ perſuaſionem, habere locum aut inveniri non poſſe in eo homine, i vel unius corporis organici, & ſpeciatim Oculi fabricam attento imo aſpexerit.* Sturm. Exerc. Acad. 9. De Viſ. Organ. & at. in Epilogo.

Fancy. We can now look about us, discern and shun the Precipices and Dangers which every where enclose us, and would destroy us. And those glorious Objects which fill the Heavens and the Earth, those admirable Works of God which every where surround us, and which would be as nothing to us, without being seen, do by Means of this noble Sense present their Glories to us (*oo*), and fill us with Admiration and Pleasure. But I need not expatiate in the

(*oo*) The glorious Landskips, and other Objects that present themselves to the Eye, are manifestly painted on the *Retina*, and that not erect, but inverted as the Laws of Optick require; and is manifest to the Eye from Monsieur *Cartes*'s Experiment, of laying bare the vitreous Humour on the Back-part of the Eye, and clapping over it a Bit of white Paper or the Skin of an Egg; and then placing the Fore-part of the Eye to the Hole of the Window of a darkned Room. By which Means we have a pretty Landskip of the Objects abroad inverted painted on the Paper, on the Back of the Eye. But now the Question is, How in this Case the Eye comes to see the Objects erect? Monsieur *Cartes*'s Answer is, *Notitia illius non nulla imagine pendet, nec ex ulla actione ab objectis veniente, sed ex solo situ exiguarum partium cerebri, e quibus Nervi expullulant.* —*Et, quod cogitandum in Oculo*——*situm capillamenti nervi optici*——*respondere ad alium quendam partis cerebri*——*qui facit ut Anima singula loca cognoscat, quæ jacent in rectâ, aut quasi rectâ lineâ; ut ita mirari non debeamus corpora in naturali situ videri, quamvis imago in oculo delineata contrarium habeat.* Dioptr. c. 6. But our most ingenious Mr. *Molyneux* answereth thus; *The Eye is only the Organ or Instrument, it is the Soul that sees by Means of the Eye. To enquire then how the Soul perceives the Object erect, by an inverted Image, is to enquire into the Soul's Faculties*——*But erect and inverted are only Terms of Relation to up and down; or farther from, or nigher to the Centre of the Earth, in Parts of the same Thing.*——*But the Eye, or visive Faculty takes no Notice of the internal Posture of its own Parts, but useth them as an Instrument only, contrived by Nature for the Exercise of such a Faculty.*——*Let us imagine, that the Eye* (on its lower Part) *receive an Impulse* [by a Ray from the upper Part of the Object] *must not the visive Faculty be necessarily directed hereby to consider this Stroke, as coming from the Top rather than the Bottom* [of the Object] *and consequently be directed to conclude it the Represent-*

tion

he Uſefulneſs and Praiſes of this Senſe, which we eceive the Benefit of every Moment, and the Want, or any Defect of which, we lament among our greateſt Misfortunes.

Leaving then this Senſe, I ſhall proceed to the ther four, but more briefly treat of them, by Reaon we have ſo ample a Sample of the Divine Art n the laſt, and may preſume that the ſame is exrted in all as well as one. For a Demonſtration of hich, let us in the next Place carry our Scrutiny the Senſe of *Hearing*.

t of the Top? Hereof we may be ſatisfied, by ſuppoſing a Man ſtand- on his Head. For here, though the upper Parts of Objects are paint- on the upper Parts of the Eye, yet the Objects are judged to be Erect: hat is ſaid of Erect and Reverſe, may be underſtood of Siniſter and xter. Molyneux's Dioptr. Nov. Part I. Prop. 28.

Chap. III. *Of the Senſe of Hearing.*

Concerning the Senſe of *Hearing*, I ſhall take Notice of two Things, the Organ, the *Ear*; nd its Object, *Sound*.

I. For the Organ, the *Ear*; I ſhall paſs by its onvenient Number of being double, which (as in e laſt Senſe) ſerves for the commodious Hearing very Way round us; as alſo a wiſe Proviſion for e utter Loſs or Injury (*a*) of one of the Ears. But ſhall a little inſiſt upon its Situation, and its adirable Fabrick and Parts. 1. It

(*a*) I preſume it will not be ungrateful to take Notice here the admirable, as well as uſeful Sagacity of ſome deaf erſons, that have learn'd to ſupply their want of *Hearing* by nderſtanding what is ſaid by the Motion of the Lips. My ery ingenious Friend Mr. *Waller*, R. S. Secr. gives this Acount: *There live now, and have from their Birth, in our Town, a*

1. It is ſituated in the moſt convenient Part of the Body, (like as I ſaid the Eye is) in a Part near the common Senſory in the Brain, to give the more ſpeedy Information; in a Part where it can be beſt guarded, and where it is moſt free from Annoyances and Harms it ſelf, and where it gives the leaſt Annoyance and Hindrance to the Exerciſes of any other Part; in a Part appropriated to the peculiar Uſe of the principal Senſes, in the moſt lofty, eminent Part of the Body, where it can perceive the moſt Objects, and receive the greateſt Information. And laſtly, in a Part in the Neighbourhood of its Siſter

Man and his Siſter, each about fifty Years old, neither of which have the leaſt Senſe of Hearing,——*yet both of theſe know, by the Motion of the Lips only, whatever is ſaid to them, and will anſwer pertinently to the Queſtion propoſed to them*——*The Mother told me they could hear very well, and ſpeak when they were Children, but both loſt the Senſe afterwards, which makes them retain their Speech; though that to Perſons not uſed to them, is a little uncouth and odd, but intelligible enough.* Philoſoph. Tranſ. No. 312.

Such another Inſtance is that of Mr. *Goddy*, Miniſter of St. *Gervais* in *Geneva*, his Daughter. *She is now about ſixteen Years old. Her Nurſe had an extraordinary Thickneſs of* Hearing *at a Year old, the Child ſpake all thoſe little Words that Children begin to ſpeak at that Age.*——*At two Years old, they perceived ſhe had loſt her* Hearing, *and was ſo Deaf, that ever ſince, though ſhe hears great Noiſes, yet ſhe hears nothing that one can ſpeak to her.*——*But by obſerving the Motions of the Mouth and Lips of others, ſhe hath acquired ſo many Words, that out of theſe ſhe hath formed a Sort of Jargon, in which ſhe can hold Converſation whole Days with thoſe that can ſpeak her own Language. I could underſtand ſome of her Words, but could not comprehend a Period, for it ſeemed to be but a confuſed Noiſe. She knows nothing that is ſaid to her, unleſs ſhe ſeeth the Motion of the Mouths that ſpeak to her; ſo that in the Night, when it is neceſſary to ſpeak to her, they muſt light a Candle. Only one thing appeared the ſtrangeſt Part of the whole Narration: She hath a Siſter, with whom ſhe hath practiſed her Language more than with any other: And in the Night, by laying her Hand on her Siſter's Mouth, ſhe can perceive by that what ſhe ſaith, and ſo can diſcourſe with her in the Night.* Biſhop *Burnet's* Let. 4. p. 248.

(b)

Siſter Senſe the Eye, with whom it hath peculiar and admirable Communication by its Nerves, as I intend to ſhew in its proper Place. In reſpect then of its Situation and Place in the Body, this Senſe is well deſigned and contrived, and may ſo far be accounted the Work of ſome admirable Artiſt. But,

2. If we ſurvey its Fabrick and Parts, it will appear to be an admirable Piece of the Divine Wiſdom, Art, and Power. For the Manifeſtation of which, let us diſtinctly ſurvey the outward and the inward Part of its curious Organ.

1. For the *outward Ear*: If we obſerve its Structure in all kinds of Animals, it muſt needs be acknowledged to be admirably Artificial, it being ſo nicely prepared, and adjuſted to the peculiar Occaſions of each reſpective Animal. In Man (*b*), it is of

(*b*) I cannot but admire that our moſt eminent modern Anatomiſts ſhould not agree, whether there be any Muſcles in the outward Ear of Man or not. Dr. *Keil* ſaith there are two; Dr. *Drake* the ſame Number; and Dr. *Gibſon* makes them to be four. So alſo doth Monſieur *Dionis*, and ſo did the ancient Anatomiſts: But Dr. *Schelhammer* expreſly denies there are any, and ſaith, *Seduxit autem reliquos Brutorum Anatome, in quorum pleriſque tales Muſculi plures inveniuntur; putârunt autem rectiſſis ignominioſum Homini, ſi non & his inſtructus eſſet, & minùs ſatis perfectum animal fore.* Schel. de Auditu, p. 1. c. 1. Sect. 7. But *Valſalva*, who wrote very lately, and is very accurate in his ſurvey of the Ear, ſaith, *Muſculi auriculæ poſteriores quandoque quatuor, quandoque duo; ſed ut plurimùm tres adnotantur; & quando ſolum duo ſe manifeſtant, tunc unus ex illis duplicato tendine verſus Conchæ deſcendi ſolet. Horum muſculorum in numero varietatem non ſolum in diverſis; verum etiam in eodem ſubjecto quandoque vidi—Ex quibus differentiis exortæ ſunt Auctorum diſcrepantiæ in horum Muſculorum numero, & ſitu:——quod non eveniſſet, ſi pluries in diverſis Corporibus iidem Muſculi quæſiti eſſent.* Ant. Mar. *Valſalvæ de Aur. Human.* c. 1. Sect. 6. But Dr. *Drake* thinks ſome of *Valſalva*'s Muſcles the Product of Fancy. Mr. *Cowper* makes them to be three, one *Attollent*, and two *Retrahent Muſcles*. See *Anat.* Tab. 12.

of a Form proper for the erect Posture of his Body. In Birds, of a Form proper for Flight; not protuberant, because that would obstruct their Progress, but close and covered, to afford the easier Passage through the Air. In Quadrupeds, its Form is agreeable to the Posture, and slower Motion of their Bodies; and in these too, various, according to their various Occasions. In some large, erect, and open, to hear the least Approaches of Dangers (*c*), in others covered, to keep our noxious Bodies. In the Subterraneous Quadrupeds, who are forced to mine and dig for their Food and Habitation, as a protuberant Ear, like that of other Quadrupeds, would obstruct their Labours, and be apt to be torn and injured; so they have the contrary (*d*), their Ears short, lodged

(*c*) *Inter cætera* [animalia aurita] *maximè admirabilis est auris leporinæ fabrica, quod cùm timidissimum animal sit, & prorsus inerme, natura id tum auditu acutissimo, tanquam hostium exploratore ad præsentienda pericula, tum pedibus ceu armis ad currendum aptis munivit videtur.* A. Kircher's *Phonurg.* l. 1. Sect. 7. Technaf. 2.

(*d*) *Moles* have no protuberant Ear, but only a round Hole between the Neck and Shoulder; which Situation of it, together with the thick, short Fur that covers it, is a sufficient Defensative against external Annoyances. The *Meatus Auditorius* is long, round and cartilaginous, reaching to the under part of the Skull. Round the inside runs a little Ridge, resembling two Threads of a Skrew; at the Bottom whereof is a pretty Inlet leading to the Drum, made, on one side with the aforesaid cochleous Ridge, and on the other, with a small Cartilage. I observed there was *Cerumen* in the *Meatus*.

As to the *inner Ear*, it is somewhat singular, and different from that of the other Quadrupeds, and much more from Birds, although I have met with some Authors that make it agreeing with that of Birds. There are three small Bones only (all hollow) by which the *Drum* (to use the old Appellation) or the *Membrana Tympani* (as others call it) acteth upon the *Auditory Nerve*. The first is the *Malleus*, which hath two Processes nearly of equal Length; the longer of which is braced to the *Membrana Tympani*, the shorter to the side

lodged deep and backward in their Head, and paſſing to the under Part thereof, and all ſufficiently fenced and guarded. And as for Inſects, Reptiles, and the Inhabitants of the Waters, if they enjoy this Senſe, (as there is great Reaſon to think they do), it may probably be lodged commodiouſly under

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ide of the *Drum* or *Os Petroſum*; the back part of it reſembles the Head and Stalk of a ſmall *Muſhroom*, ſuch as are pickled. On the back of the *Malleus* lies the next ſmall Bone, which may be called the *Incus*, long, and without any Proceſs, having ſomewhat the Form of the ſhort Scoop wherewith Water-men throw the Water out of their Wherries. To the end of this the third and laſt ſmall Bone is tacked by a very ſlender Brace. This little Bone bears the Office of the *Stapes*, but is only forked without any Baſe. One of theſe Forks is at one *Feneſtra*, or *Foramen*, the other at another; in which *Feneſtra* I apprehend the Forks are tacked to the Auditory Nerve. Theſe *Feneſtræ* (equivalent to the *Feneſtra Ovalis*, and *Rotunda* in others) are the Inlets into the *Cochlea* and *Canales Semicirculares*, in which the *Auditory Nerve* lieth. The *Semicircular Canales* lie at a diſtance from the *Drum*, and are not lodged (as in other Animals) in a ſtrong, thick Body of Bone, but are thruſt out, within the Skull, making an *Antrum*, with an handſome *Arch* leading into it, into which a part of the Brain enters.

One Leg of the *Malleus* being faſtned to the *Membrana Tympani*, and the *Incus* to the back of the *Malleus*, and the top of that to the top of the *Stapes*, and the Forks or Branches of the *Stapes* to the *Auditory Nerve*, I obſerved that whenever I moved the Membrane, all the little Bones were at the ſame time moved, and conſequently the *Auditory Nerve* thereby affected alſo.

I hope the Reader will excuſe me for being ſo particular in this Organ only of the *Mole*, a deſpiſed Creature, but as notable an Example of *God*'s Work, as its Life is different from that of other Quadrupeds; for which Reaſon it partly is that I have enlarged on this part differing from that of others, and which no Body that I know of, hath taken much notice of, and which is not diſcoverable without great Patience and Application; and partly becauſe by comparing theſe Obſervations with *Book* VII. *Chap.* 2. *Note* (*d*), we may judge how the Senſe of Hearing is performed.

der the same Security and Guard, as the Smelling or some other Sense is.

And moreover, as the Form of this Organ is various in various Animals, so in each of them its Structure is very curious and observable, being in all admirably contrived to collect the wandering circumambient Impressions, and Undulations of Sound, and to convey them to the Sensory within. If I should run over the several *Genera* of Animals, we might find a notable Prospect of the Handy-work of God (*e*), even in this so inconsiderable a Part of Animals. But I shall only carry my Survey to that of Man. And here the first Thing that offereth it self to our View, is the *Helix*, with its tortuous Cavities, made to stop, and collect the sonorous Undulations, to give them a gentle Circulation and Refraction, and so convey them to the *Concha*, or larger and more capacious round Cell at the Entrance of the Ear. And to bridle the Evagation of the Sound, when arrived so far, but withal not to make a Confusion thereof, by any disagreeable Repercussions, we may take Notice of a very curious Provision in those little Protuberances, called the *Tragus*,

(*e*) *Among many Varieties, both in the inner and outer Ear, those which appear in the Passages into the Rock-Bone, are remarkable. For in an* Owl, *that perches on a Tree or Beam, and hearkens after the Prey beneath her, it is produced farther out above than it is below, for the better Reception of the least Sound. But in a* Fox, *that scouteth underneath the Prey at Roost, it is for the same Reason produced farther out below. In a* Pole-Cat, *which hearkens strait forward, it is produced behind, for the taking of a forward Sound. Whereas in a* Hare, *which is very quick of Hearing, and thinks of nothing but being pursued, it is supplied with a bony Tube, which, as a natural Otocoustick, is so directed backward, as to receive the smallest and most distant Sound that comes behind her.* Grew's Cosmolog. Sacr. *lib.* 2. *c.* 5. *Sect.* 6.

(*f*) The

Tragus, and *Antitragus* of the outward Ear, of a commodious Form and Texture (*f*), and conveniently lodged for this Uſe. The great Convenience and Benefit of this Form and Contrivance of the outward Ear, is ſufficiently manifeſt by the want thereof, which cauſeth a *Confuſion in the Hearing, with a certain Murmur, or Swooing like the fall of Waters* (*g*).

Another wiſe Proviſion of the Creator, is in the ſubſtance of the outward Ear, which is cartilaginous, the fitteſt for this Place. For (as an ingenious Anatomiſt (*h*) obſerves, "If it had been Bone, it would have been troubleſome, and might by many Accidents have been broken off: If Fleſh, it would have been ſubject to Contuſion". But need a worſe Conſequence than this would have if'd ſuch a Softneſs as that of Fleſh, and that is, would neither have remain'd expanded, neither could it ſo kindly receive and circulate the Sounds, or abſorb, retard, or blunt their Progreſs into the inward Organ. But being hard, and curiouſly ſmooth and tortuous, Sounds find an eaſy Paſſage, with a regular Volutation and Refraction: As in a well-built Arch, Grotto, or muſical Inſtrument, which magnify and meliorate Sounds; and ſome of

(*f*) The Texture of the *Tragus* and *Antitragus*, is ſofter than that of the *Helix*, which ſerveth gently to blunt, not forcibly to repel the Sound in the *Concha*.

(*g*) Dr. *Gibſon*'s Anatomy, *Chap.* 22. *Book* III. *Thoſe whoſe Ears are cut off, have but a confuſed way of Hearing, and are obliged either to form a Cavity round the Ear with their own hands, or elſe to make uſe of a Horn, and apply the end of it to the inner Cavity of the Ear, in order to receive the agitated Air. 'Tis likewiſe obſerved, that thoſe whoſe Ears jut out, hear better than flat-eared perſons.* Monſieur *Dionis*'s Anat. Demonſtr. 8.

(*h*) *Gibſ.* Ibid.

(*i*) It

of which convey even a Whiſper to a large Di
tance (*i*): But from the outward, let us carr
our Survey,

2. To this inward Part of this admirable Orga
And here we find the moſt curious and artful Pro
viſion for every Emergency and Occaſion. The *a
ditory Paſſage*, in the firſt Place, curiouſly tu
nelled, and artfully turned, to give Sounds an e
Paſſage, as well as a gentle Circulation and Re
fraction; but withal, ſo as to prevent their to
furious ruſhing in, and aſſaulting the more tend
Parts within.

And foraſmuch as it is neceſſary that this Paſſa
ſhou

(*i*) It would nauſeate the Reader to reckon up the Pla
famed for the Conveyance of Whiſpers, ſuch as the Pri
of *Dionyſius* at *Syracuſe*, which is ſaid to increaſe a Whiſper
a Noiſe; the clapping ones Hands to the Sound of a Ca
non, &c. Nor the *Aquæductis* of *Claudius*, which carry a Vo
ſixteen Miles, and many others both Ancient and Mode
If the Reader hath a mind to be entertained in this w
he may find enough in *Kircher's Phonurgia*. But it may n
be irkſome to mention one or two of our own in *Engla*
Among which, one of the moſt famed is the *Whiſpering-Pl*
in *Glouceſter Cathedral*, which is no other than a Gallery abo
the Eaſt-end of the Choir, leading from one ſide thereof
the other. It conſiſteth (if I miſtake not) of five Angl
and ſix Sides, the middlemoſt of which is a naked, unc
vered Window, looking into a Chapel behind it. I gue
the two Whiſperers ſtand at about twenty five Yards Di
tance from one another. But the *Dome* of St. *Paul's*, *Lon*
is a more conſiderable *Whiſpering-Place*, where the ticking of
Watch (when no Noiſe is in the Streets) may be heard fro
Side to Side; yea, a Whiſper may be ſent all round the *Dom*
And not only in the Gallery below, but above, upon the Sca
fold, I tried, and found that a Whiſper would be carried ov
one's Head round the Top of the Arch, notwithſtanding the
is a large Opening in the Middle of it, into the upper Pa
of the *Dome*.

(*k*) *Audi*

ould be always open, to be upon the Watch (*k*); erefore to prevent the Invaſion of noxious In-ts, or other Animals, (who are apt to make eir Retreat in every little Hole,) Nature hath cured this Paſſage (*l*), with a bitter nauſeous crement (*m*), afforded from the Glands (*n*) ap-inted for that Purpoſe, From

(*k*) *Auditus autem ſemper patet: ejus enim ſenſu etiam dormientes mus: A quo cùm ſonus eſt acceptus, etiam è ſomno excitamur. Flex-um iter habet, nè quid intrare poſſit, ſi ſimplex, & directum pateret; ipſum etiam, ut ſiqua minima beſtiola conaretur irrumpere, in ſor-s aurium, tanquàm in viſco, inhæreſceret.* Cicer. de Nat. Deor, . c. 57.

t deſerves a particular Remark here, that in Infants in Womb, and newly Born, the *Meatus Auditorius* is ſhut up y cloſely, partly by the Conſtriction of the Paſſage, and rtly by a glutinous Subſtance, whereby the *Tympanum* is arded againſt the Water in the *Secundine*, and againſt the uries of the Air as ſoon as the Infant is born.

(*l*) It is remarkable, that in moſt, if not all Animals, whoſe rs are tunnelled, or where the *Meatus Auditorius* is long ough to afford Harbour to *Ear-wigs*, or other Inſects; that, y, in the Ears of ſuch, *Ear-wax* is conſtantly to be found. t in Birds, whoſe Ears are covered with Feathers, and ere the *Tympanum* lies but a little Way within the Skull, *Ear-wax* is found, becauſe none is neceſſary to the Ears ſo ll guarded, and ſo little tunnelled.

(*m*) The *Ear-wax* was thought, by the old Anatomiſts, to an Excrement of the Brain: *Humor bilioſus à cerebro expugna-*, the *Bartholines* ſay of it, *l.* 3. *c.* 9. But as *Schelhammer* well ſerves, *Nil abſurdius, quàm cerebri excrementum hoc ſtatuere. am & ratio nulla ſuadet, ut in cerebro fieri excrementum tale creda-us:——neque viæ patent per quas ab eo ſecluſum in meatum audi-ium poſſit inde penetrare.* As to its Taſte, *Caſſerius* gives In-ances of its being Sweet in ſome Creatures. But *Schelhammer* ys, *Ego verò ſemper, cum amaritie aliquid dulcedinis in illo depre-ndi.* Vide Schel. de Audit, *p.* 1. *c.* 2. *ſect.* 10. But I could ver diſtinguiſh any Sweetneſs in it; but think it inſipid ixed with a Bitterneſs.

(*n*) *Cerumina amara Arteriolis exudantia.* Willis de Anim. Brut. r. 1. *c.* 14. *In the Skin——are little Glands, which furniſh a yellow d bitter Humour.* Monſieur *Dionis*'s Dem. 18. An handſome ut of thoſe *Glandulæ Ceruminoſæ* is in Dr. *Drake*, from *Valſalva*.

Pliny

From hence let us approach the moſt inwar Parts, in which we ſhall ſee Strokes of the mo exquiſite Art. To paſs over the *innate Air*, th moſt Authors talk of (*o*), (becauſe there is no ſuc the Paſſage to the Palate (*p*), and their Uſes, wi divers other curious Things that might be name

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Pliny attributes a great Virtue to the *Ear-wax*; *Morſu minis inter aſperrimos numeratur: medentur ſordes ex auribus: a quis miretur, etiam Scorpionum ictibus Serpentiumque ſtatim imp* Plin. Nat. Hiſt. *l.* 28. *c.* 4. And that it hath an hea Quality, and may be accounted a good Balſam, I my have experienced.

(*o*) That there is ſuch a Thing as the *innate Air*, (tal of much by moſt Authors on this Subject) *Schelhammer* juſtly, I think, denies; by Reaſon there is a Paſſage into inner Ear from the Throat, through which the *innat* may paſs out, and the outward Air enter in. *Vide Par.* p. 2. c. 1. ſect. 10. When by ſtopping our Breath, and ſtr ing, we force the external Air into the Ear, it may be he ruſhing in; and if much be forced in, it may be felt alſ beat againſt the *Tympanum*. When the Paſſage to the Th is by any Means ſtopped, as by a Cold in the Head, &c. Hearing thereby becomes dull and blunt; by Reaſon Communication between the outward and inward Air obſtructed: But when by ſtrong Swallowing, or ſuch Motion of the Throat, the Paſſage is opened, we perceiv by a ſudden Smack or Crack, and we immediately hear clearly; the load of feculent Air being at that Time d charged from the inner Ear.

It is a wiſe Proviſion, that the Paſſage for the Air into Ear, is from the Throat; *Ut non ſtatim quivis aer externus vumpere queat* (as *Schelhammer* ſaith, *Par. ult. c.* 4. *Sect.* 8.) *nonnihil immutatus, ac temperatus, calore ex medio ventre exſpirat imò fortaſſis non facilè alius, niſi ex pulmonibus.*

(*p*) *Valſalva* hath given us a more accurate Deſcriptio the *Tuba Euſtachiana*, or *Paſſage to the Palate*, than any oth Author, to whom I therefore refer, *De Aur. Human.* c. 2. Sc 16, &c.

The chief Uſe hereof, he thinks, is to give way to the i ner Air, upon every Motion of the *Membrana Tympani*, t *Malleus*, *Incus* and *Stapes*. This Paſſage, if it be ſhut Deafneſs enſues: Of which he gives two Inſtances: One Gentlem

us ſtop a little at the Part containing the reſt, mely, the Bone (*q*). The particular Texture and rdneſs of which, above other Bones of the Body, very remarkable; whereby it ſerves not only as ubſtantial Guard to the Senſory, but alſo to op- ſe the Impulſes of the ætherial Matter, that there y be no Loſs nor Confuſion in the Sound; but t it may be convey'd regularly, and intirely to auditory Nerves.

The next Part I ſhall take Notice of, may be t fine Membrane, called the *Tympanum*, or *embrana Tympani* (*r*), with its inner Membrane;

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ntleman, who loſt his Hearing by a Polypus in the Noſe ching to the *Uvula*; the other a Yeoman, labouring with Ulcer above the left Side of the *Uvula*; which when he t with a Tent dipped in Medicine, he loſt his Hearing he left Ear, and recovered it, as ſoon as the Tent was . *Ibid.* c. 5. Sect. 10.

q) Os [petroſum] *ex quo interiores* [Labyrinthi] *cavitatum tes conflati ſunt, album, duriſſimum, necnon maximè compactum. utem à Naturâ ita comparatum eſſe videtur, ut materia æthereæ rum objectorum impreſſionibus onuſta, dum prædictis impingitur ietibus, nihil aut ſaltem ferè nihil motûs ſui amittat, atque adeò n qualem ab Objectis ſonoris accepit, talem communicet ſpiritui ani- i contento intra expanſiones rami mollioris Nervorum auris.* Dr. *m. Vieuſſens* of *Montpellier*, in Phil. Tranſ. No. 258.

r) The *Tympanum* of the Ear, or as *Valſalva* and the Mo- ns, the *Membrana Tympani* was taken notice of as early as *pocrates*'s Time. In Birds, it is ſtrained towards the out- rd Parts; in other Animals towards the Brain, or inner rts. Monſieur *Dionis* ſaith, *It is not equally faſtened to the le Circumference of the bony Circle, in which it is inchaſed; for on upper ſide it hath a free diſengaged Part, by which ſome can give t to the Smoak in their Mouth.* Demonſtr. 8. That there is me Paſſage I doubt not, but I queſtion whether Monſieur *nis* ever ſaw the diſengaged Part he mentions. I have my f carefully ſearched divers Subjects, and do not remem- r to have ſeen any ſuch Paſſage; and I perceive it eſcaped e diligent *Schellammer*'s Eye. *Valſalva* alſo by injecting in rough the *Tuba Euſtachiana*, cou'd not force any Liquor into

brane (*s*); together with the four little appende
Bones (*t*), and the three inner Muſcles to mo
them, and adjuſt the whole *Compages* to the ſeve

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into the *Meatus Auditorius*; but yet he imagines he found
Paſſage out in another Place of the Drum, in ſome mo
and one ſound Head. *Valſalv. de Aur. Hum.* c. 2. Sect. 8.
Cowper alſo affirms there is a Paſſage by the upper Par
the Membrane. *Anat. Ap.* Fig. 8.

(*s*) Dr. *Vieuſſens*, before-named, diſcovered a Membr
tenuiſſima rarăque admodum textura intra cavitatem Tympani; a
deſcribes it. Whoſe uſe he ſaith is, 1. *Occludens Labyr
januam impedit ne naturalis puriſſimus ac ſubtiliſſimus Aer intra c
tates——communicationem——habeat cum aere craſſo*, 2. *Labyr
baſin calefacit*, &c. *ubi ſupra*. Probably this double Membr
may be ſuch, or after the ſame manner as it is in the
panum of Birds: Of which ſee my Obſervations in *Book*
Chap. 2. *Note* (*d*).

(*t*) The four little Bones being treated of by all that
concerned themſelves about this Senſe of Hearing,
their Diſcovery, I ſhall take Notice of only two Things
cerning them. 1. The Diſcovery of them is owing wholly
the Diligence and Sagacity of the latter Ages; of wh
Schelhammer gives this Account from *Fallopius*: *Hæc Oſſicula a
quis Anatomicis——ignota fuere; primuſque qui in lucem pro
[Malleum & Incum] *fuit Jac. Carpenſis; primus quoque p
omni dubio Anatomicæ artis, quam Veſalius poſtea perfecit, reſtaur
Tertium* [Stapedem] *invenit ac promulgavit primus Joh. Phil.
Ingraſſia, Siculus, Philoſophus, ac Medicus doctiſſimus. Quart
Thomâ Bartholin. teſte, viro longè celeberrimo, Fran. Sylvio de
Schel. *ubi ſupra*, c. 3. Sect. 9. 2. Their Difference in A
mals: In *Man*, and *Quadrupeds*, they are four, curiouſly i
ticulated with one another; with an external and inter
Muſcle to draw, or work them, in extending, or relax
the *Drum*; but in *Fowls* the Caſe is very different: *His w
Oſſiculum ſolum largita eſt Natura, quod Collumellam fortè appe
veris: teres enim eſt & ſubtiliſſimum, baſi innitens latiori, rotun
Huic adnexa eſt cartilago valde mobilis, quæ in Tympanum videtur
minari.* Id. Ib. Sect. 8. *In the Ears of all the Fowl that I could
mine, I never found any more than one Bone, and a Cartilage, mak
a Joynt with it, that was eaſily moveable. The Cartilage had ge
rally an Epiphyſe, or two, one on each Side.——The Bone was
hard and ſmall, having at the end of it a broad Plate, of the ſa
Subſtance, very thin, upon which it reſted, as on its Baſis.* Dr.
Moulen in Phil. Tranſ. No. 100.

rpoſes of Hearing, to hear all manner of Sounds, id or languid, harſh or grateful (*u*). From

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Theſe are the moſt material Things I find obſerved by o- rs, concerning the Ears of Fowls, and ſome of them dly, I believe, obſerved before. To which I ſhall ſubjoyn e other Things I have my ſelf diſcovered, that I preſume ped the Eyes of thoſe moſt curious and inquiſitive Anato- ts. Of which the laſt cited *Book* VII. *Chap.* 2. *Note* (*d*).

(*u*) *Videtur quòd Tympanum Auditionis inſtrumentum præliminare, quaſi præparatorium fuerit, quod Soni impreſſionem, ſive ſpecies ſenſ- s primo ſuſpiciens, eas in debitâ proportione, & aptâ conformitate, s Senſorium, quod adhuc interius ſitum eſt, dirigat: ſimili officio tur reſpectu Auditûs, ac tunicæ Oculi Pupillam conſtituentes, re- Viſûs; utræque Membranæ Species ſenſibiles refringunt & quaſi iunt, eaſque Senſorio non niſi proportionatas tradunt, cui nudo ſi niant, teneriorem ejus craſin facile lædant, aut obruant. Revera panum non audit, ſed meliori tutiorique Auditioni confert. Si hæc deſtruatur, Senſio adhuc aliquamdiu, redi licet modo, peragi poſſit; e experimento olim in Cane facto, &c.——Janitoris officio ut panum rectè defungi poſſit, expanſum ejus pro datâ occaſione ſtringi, elaxari debet, veluti nimirùm Oculi Pupilla——Quapropter huic s Tympano, non ſecus ac bellico, machinæ ſive tæniæ quædam ap- tur, quæ ſuperficiem ejus modò tenſiorem, modò laxiorem reddant: nim efficiunt tria Oſſicula, cum Muſculo, &c.* Willis de Anim, . c. 14.

or this Opinion of Dr. *Willis*, Dr. *Schelhammer* is very ſe- upon him, deriding the Refractions he ſpeaks of; and efore ſeriouſly proves that they are the Humours, not icks of the Eye, that refract the Rays of Light; and jeeringly demandeth, Whether the ſonorous Rays are acted by paſſing through a different Medium? Whether Convexity or Concavity of the Drum collects thoſe Rays a focal Point, or ſcatters them? &c. And then ſaith, *Ob rationes à clariſſ. Viri, ac de re Medicâ præclare meriti, ſententiâ poſſumus non eſſe alieniores; in quo uti ingenium admiror, quoties camentorum vires, aut morborum cauſas explicat, ſic ubi ſorum egreſſus Philoſophum agit, ac vel Partium uſum, vel Chymica- verum naturam ſcrutetur, ejus haud ſemel non modò judicium de- o, verùm aliquando etiam fidem.* This is ſo ſevere and un- à Cenſure of our truly famous Countryman, (a Man of wn Probity) that might deſerve a better Anſwer; but I e only Time to ſay, that although Dr. *Schelhammer* hath done all that wrote before him, in his Book *de Auditu*, ſhewed himſelf a Man of Learning and Induſtry; yet

as

From this Region of the *Tympanum*, I might pass

as our Countryman wrote more than he, (though perhaps not free from Errors too) so he hath manifested himself to have been as curious and sagacious an Anatomist, as great a Philosopher, and as learned and skilful a Physician, as any of his Censurers, and his Reputation for Veracity and Integrity, was no less than any of theirs too. But after all this terrible Clamour, Dr. *Schelhammer* prejudicately mistakes Dr. *Willis*'s Meaning, to say no worse. For by *utræque Membranæ refringunt*, Dr. *Willis* plainly enough, I think, means no more than a Restriction of the Ingress of too many Rays, as his following explicatory Words manifest, *viz. refringunt, & quasi emolliunt, easque Sensorio non nisi proportionatas tradunt.* But indeed Dr. *Schelhammer* hath shewn himself a too rigid Censor, by making Dr. *Willis* say, the *Ear-Drum* hath such like Braces as the *War-Drum*, viz. *Quod porrò de machinis seu tensis Tympani bellici adducit, dicitque idem in Tympano auditorio conspici, id prorsus falsissimum est.* I wonder Dr. *Schelhammer* did not also charge Dr. *Willis* with making it a Porter, since he saith in the same Paragraph, *Janitoris officio, &c.* But Dr. *Willis*'s Meaning is plain enough, that the little Bones and Muscles of the *Ear-Drum* do the same Office in straining and relaxing it, as the Braces of the *War-Drum* do in that. And considering how curious and solemn an Apparatus there is of Bones, Muscles, and Joynts, all adapted to a ready Motion; I am clearly of Dr. *Willis*'s Opinion, that one great Use of the *Ear-Drum* is for the proportioning Sounds, and that by its Extension and Retraction, it corresponds to all Sounds, loud or languid, as the Pupil of the Eye doth to several Degrees of Light: And that they are no other than secondary Uses assigned by Dr. *Schelhammer*, as the principal or sole Uses of keeping out the external colder Air, Dust, and other Annoyances; but especially that, *Ob solius aeris interni potissimùm irrumpentis vim, hunc motum Tympani ac Mallei esse conditum, ut celeriùs primùm, deinde sibi restitui queat*; as his Words are, *P. ult. c.* 6. sect. 13.

It was no improbable Thought of *Rohault*, *Nos attentos præbere, nil aliud est, nisi* Tympanum, *ubi ita opus est facto, contendere aut laxare, & operam dare ut illud in eâ positione intentum stet, in quâ tremulum aeris externi motum commodissime excipere possit.* Rohault Phys. p. 1. c. 26. sect. 48.

The Hearing of deaf Persons more easily by Means of loud Noises, is another Argument of the Use of the Straining or Relaxation of the *Tympanum* in Hearing. Thus Dr. *Willis*

pass to that of the *Labyrinth* (*w*), and therein sur-
vey

ubi supra) *Accepi olim à viro fide digno, se mulierem novisse, quæ cet surda fuerit, quousque tamen intra conclave Tympanum pulsaretur, erba quævis clarè audiebat: quare Maritus ejus Tympanistam pro rvo domestico conducebat, ut illius ope colloquia interdum cum Uxore ad haberet. Etiam de alio Surdastro mihi narratum est, qui prope ampanile degens, quoties una plures Campanæ resonarent, vocem quam-is facile audire, & non alias, potuit.*

Abscisso Musculo [Processus majoris Mallei] *in recenti aure, re-natur* [Tympani Membrana.] *Valsalv. de Aur. Hum.* c. 2. sect. 5.

Upon considering the great Difference in Authors Opi-ns about the Use of the Parts, and Manner how Hearing is erformed, as also what a curious Provision there is made in e Ear, by the four little Bones, the Muscles, Membrane, c. I was minded (since I penned this Note) to make enqui-my self into this Part, and not to rely upon Authority. nd after a diligent Search of various Subjects, I find we ay give as rational and easy an Account of Hearing, as of eing, or any other Sense; as I have shewn in my last cited ote (*d*), *Book* VII. *Chap.* 2. with relation to Birds. And as Men and Beasts, the Case is the same, but the Apparatus ore complex and magnificent. For whereas in Birds, the *ditory Nerve* is affected by the Impressions made on the *Membrane*, by only the Intermediacy of the *Columella*; in lan, it is done by the Intervention of the four little Bones, ith the Muscles acting upon them; his Hearing being to be djusted to all kinds of Sounds, or Impressions made upon the *embrana Tympani*. Which Impressions are imparted to the *uditory Nerve*, in this Manner, *viz.* First they act upon the *Membrane* and *Malleus*, the *Malleus* upon the *Incus*, and the *cus* upon the *Os Orbiculare* and *Stapes*; and the *Stapes* upon e *auditory Nerve*: For the Base of the *Stapes* (the same as e *Operculum* in Birds) not only covers the *Fenestra Ovalis*, ithin which the *auditory Nerve* lieth, but hath a Part of the *uditory Nerve* spread upon it too. It is manifest that this is e true Process of Hearing; because if the *Membrane* be ov'd, you may see all the Bones move at the same Time, nd work the Base of the *Stapes* up and down in the *Fenestra valis*, as I shewed in this Chapter, *Note* (*d*), concerning the *Mole*; and as it may be seen in other Ears carefully opened, the Parts remain *in situ*.

(*w*) I do not confine the *Labyrinth* to the *Canales Semicircu-res*, or any other Part, as the elder Anatomists seem to have one, who by their erroneous and blind Descripsions seem not

vey the curious and admirable Structure of the *Vestibulum*, the *Semicircular Canals* (*x*), and *Cochlea*; particulary the artificial Gyrations, and other singular Curiosities observable in the two latter.

But I shall not expatiate on these recluse Parts; only there is one special Contrivance of the Nerves ministring to this Sense of Hearing, which must not be passed by; and that is, the Branches of one of the *auditory Nerves* (*y*), spread partly to the Muscles of the Ear, partly to the Eye, partly to the Tongue

well to have understood these Parts; but with those much more curious and accurate Anatomists, Monsieur *de Verney*, and Dr. *Valsalva*; under the *Labyrinth*, I comprehend the *Canales Semicirculares*, and the *Cochlea*, together with the intermediate Cavity, called by them the *Vestibulum*.

(*x*) In the *semicircular Canals*, two Things deserve to be noted. 1. That the three Canals are of three different Sizes, *Major*, *Minor*, and *Minimus*. 2. Although in different Subjects, they are frequently different; yet in the same Subject they are constantly the same. The Reason of all which, together with their Uses, *Valsalva* ingeniously thinks is, that a Part of the tender *auditory Nerve* is lodged in these Canals; so they are of three Sizes, the better to suit all the Varieties of Tones; some of the Canals suiting some, and others, other Tones. And although there be some Difference as to the Length and Size of these Canals, in different Persons; yet lest there should be any discord in the auditory Organs of one and the same Man, those Canals are always in exact Conformity to one another in one and the same Man. *V. Valsal. supr.* Ch. 3. Sect. 7. and Ch. 6. Sect. 4. 9.

(*y*) *Hic posterior Nervus extra cranium delatus, in tres ramos dividitur, qui omnes motibus patheticis——inserviunt. Primus——musculis Auris impenditur. Proculdubio hujus actione efficitur, ut a malia quævis, à subito soni impulsu, aures, quasi sonum nimis transeuntem captaturas erigant. Ramus alter——versus utrum otuli angulum furculos emittit: qui musculis palpebrarum attollentibus inseruntur; quorum certè munus est ad subitum soni appulsum oc confestim aperire, eosque velut ad Excubias vocare.——Tertius——ra versus Linguæ radicem descendens, musculis ejus & ossis Hyoeidei tribuitur, adeoque organa quædam vocis edendæ actuat, &c.* Willis Cerebr. Anat. c. 17.

(z) E

Tongue and Inſtruments of Speech, and inoſculated with the Nerves to go to the Heart and Breaſt. By which Means there is an admirable and uſeful Conſent between theſe Parts of the Body; it being natural for moſt Animals, upon the Hearing any unkouth Sound, to erect their Ears, and prepare them to catch every Sound; to open their Eyes (thoſe conſtant faithful Centinels) to ſtand upon their Watch; and to be ready with the Mouth to call out, or utter what the preſent Occaſion ſhall dictate. And accordingly it is very uſual for moſt Animals, when ſurpriz'd, and terrify'd with any Noiſe, preſently to ſhriek and cry out.

But there is beſides this, in Man, another great Uſe of this nervous Commerce between the Ear and Mouth; and that is, (as one of the beſt Authors on this Subject expreſſeth it) (z), "That the Voice may correſpond with the Hearing, and be a kind of Echo thereof, that what is *heard* with *one* of the two Nerves, may be readily expreſſed with the Voice, by the Help of the *other*.

Thus much ſhall ſuffice to have ſpoken concerning the Organ. Let us,

II. Take Notice of the *Object* of this admirable Senſe, namely, *Sound*; and ſo conclude this Chapter. I ſhall not here enquire into the Nature and Properties of *Sound*, which is in a great Meaſure intricate, and hath puzzelled the beſt Naturaliſts: Neither ſhall I ſhew how this admirable Effect of the Divine Contrivance, may be improv'd to divers Uſes

(z) *Hujuſmodi Nervorum conformatio in Homine uſum alium inſignierem præſtat, nempe ut Vox, &c.* Willis Ibid.

Uſes [*aa*] and Purpoſes in Humane Life; but my Buſineſs will be to ſhew that this Thing, of ſo admirable Uſe in the animal World, is the Work of God,

(*aa*) Among the Uſes to which the Wit of Man hath employ'd Sounds, we may reckon the Inſtruments uſeful in convocating Aſſemblies, managing Armies, and many other Occaſions, wherein Bells, Trumpets, Drums, Horns, and other ſounding Inſtruments are uſed; the Particularities of which it would be tedious to recount: As that the biggeſt *Bell* in *Europe* is reckoned to be at *Erfurt* in *Germany*, which they ſay may be heard twenty four Miles; with much more to the ſame Purpoſe. I ſhall therefore only for a Sample take notice of the *Speaking-Trumpet*; the Invention of which is commonly aſcribed to our eminent Sir *Samuel Morland*; but was more probably *Ath. Kircher*'s; at leaſt he had contrived ſuch an Inſtrument, before Sir *Samuel* hit upon his. *Kircher* in his *Phonurg.* ſaith, The *Tromba* publiſhed laſt Year in *England*, he had invented twenty four Years before, and publiſhed in his *Miſurgia*; that *Jac. Albanus Ghibbeſius*, and *Fr. Eſchinardus* aſcribe it to him; and that *G. Schottus* teſtifieth he had ſuch an Inſtrument in his Chamber in the *Roman College*, with which he could call to, and receive Anſwers from the Porter. And conſidering how famed *Alexander the Great*'s Tube was, which is ſaid might be heard 100 *Stadia*, it is ſomewhat ſtrange that no Body ſooner hit upon the Invention. Of the *Stentorophonick Horn* of *Alexander*, there is a Figure preſerved in the *Vatican*, which for Curioſity ſake, I have from *Kircher* repreſented in *Fig.* 3. He ſaith its Diameter was five Cubits, and that it was ſuſpended on a Supporter.

For the Make of the *Speaking-Trumpet*, and the Reaſon why it magnifies Sounds, I ſhall refer to *Kircher*; eſpecially to Sir *Samuel Morland*'s *Tuba Stentoroplonica*, Publiſhed in 167[illegible].

Kircher ſaith, he took one of theſe Trumpets of fifteen Palms length, along with him to the *Mons Euſtachianus*, where he convocated 2200 Perſons to Prayers, by means of the unuſual Sound, at two, three, four, and five *Italian* Miles Diſtance.

With theſe *Bellowing-Trumpets*, I ſhall join ſome *Bellowing Caves* for the Reader's Diverſion. *Ol. Magnus* deſcribes a Cave in *Finland*, near *Viburg*, called *Smellen*, into which, if a Dog, or other Living Creature be caſt, it ſends forth ſo dreadful a Sound, that knocks down every one near it. For which Reaſon they have guarded the Cave with high Walls

God. And this will appear, let the ſubject Matter of Sounds be what it will; either the Atmoſphere (*bb*) in Groſs, or the ætherial Part thereof, or ſoniferous Particles of Bodies, as ſome fancy, or what-

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revent the Miſchiefs of its Noiſe. *Vid. Ol. Magn. Hiſtor.* l. 11. . 4. Such another *Peter Martyr* ſaith is in *Hiſpaniola*, which, ith a ſmall Weight caſt into it, endangers Deafneſs at five iles Diſtance. And in *Switzerland*, *Kircher* ſaith, in the *ucumer-Mountain* is a Pit that ſends out both a dreadful Noiſe nd a great Wind therewith; and that there is a Well in his ountry 3000 Palms deep, whoſe Sound is equal to that of great Gun. *Vid. Kirch. Pkonurg.*

Ol. Magnus ſpeaking of the vaſt high Mountains of a Nortern Province, call'd *Angermannia*, ſaith, *Ubi baſes eorum in profundiſſimo gurgite ſtantes, caſu aliquo, vel propoſito Nautæ acceſſerint, ntum horrorem ex altâ fluctuum colliſione percipiunt, ut niſi præcipiti migio, aut valido vento evaſerint, ſolo pavore ferè exanimes fiant, mulue dierum curriculo, ob capitis turbationem, priſtinæ mentis, & ſaniis compotes vix evadant. Habent baſes illorum montium in fluctuum greſſu & regreſſu tortuoſas rimas, ſive ſciſſuras, ſatis ſtupendo naturæ ficio fabricatas, in quibus longâ varagine formidabilis ille Sonitus aſt ſubterraneum tonitru generatur.* Ol. Magn. l. 2. c. 4. See ſo *Chap.* 12.

(*bb*) That the Air is the Subject, or *Medium* of Sound, is anifeſt from the Experiments in rarefied and condenſed ir. In an unexhauſted Receiver, a ſmall Bell may be heard the Diſtance of ſome Paces; but when exhauſted, it can arce be heard at the neareſt Diſtance: And if the Air be ompreſſed, the Sound will be louder, proportionably to the ompreſſion or Quantity of Air crouded in, as I have often ried my ſelf, and may be ſeen in Mr. *Hawksbee*'s curious Experiments, p. 97. Alſo his Experiments in *Phil. Tranſ.* No. 321.

Neither doth this ſucceed only in forced Rarefactions and Condenſations of the Air, but in ſuch alſo as are natural; as s evident from *David Frœdlichius* in *Varenius*, upon the higheſt Eminencies of *Carpathus*, near *Keſmarckt* in *Hungary*. The tory of *Frœdlichius* is this, *Ego Menſe Junii* 1615. *tum adoleſcens, ublimitatem horum montium, cum duobus comitibus Scholaribus, exeriri volens, ubi, cùm in primæ rupis vertice, magno labore, me ſummum terminum aſſecutum eſſe putarem, demum ſeſe obtulit alia multo ltior cautes, ubi pervaſta eaque vacillantia ſaxa (quorum unum, ſi loco à viatore dimovetur——aliquot centena ——rapit, & quidem*

whatever elſe the Philoſophers may think it. For who but an Intelligent Being, what leſs than an Omni-

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tanto cum fragore, ut illi metuendum ſit nè totus Mons corruat, eumque obruat) enixus eſſem, iterum alia ſublimior prodiit, &c. donec ſummo vitæ periculo ad ſupremum cacumen penetraverim. Ex declivioribus montibus cùm in ſubjectas valles, ——nil niſi obſcuram noctem, aut cœruleum quid, inſtar profundi aëris, quod vulgò ſudum cœlum appellatur, obſervare potui mihique videbar, ſi de monte caderem, non in terram, ſed rectè in ſolum me prolapſurum. Nimia enim declivitate, ſpecies viſibiles extenuatæ & habetatæ fuerunt. Cum verò altiorem montem peterem, quaſi intra nebulas denſiſſimas barbam——Et cum non procul à ſummo vertice eſſem de ſublimi quieſcens proſpexi & animadverti iis in locis, ubi mihi antea videbar intra nebulas baſiſſe, compactas atque albas ſeſe movere nubes, ſupra quas, per aliquot milliaria, & ultra terminos Sepuſi commodus mihi proſpectus patuit. Alias tamen etiam nubes altiores, alias item humiliores, necnon quaſdam æqualiter à terrâ diſtantes vidi. Atque hinc tria intellexi. 1. Metum tranſiviſſe principium mediæ Aeris regionis. 2. Diſtantiam nubium à terra, non eſſe æqualem.—3. Diſtantiam nubium —non Mill. Ger. ut quidam— ſed tantum dimidiatum Mill. Ger. In ſummum montis verticem cùm perveniſſem, adeò tranquillum & ſubtilem aërem ibi offendi, ut nè pili quidem motum ſentirem, cùm tamen in depreſſioribus ventum vehementem expertus ſim: unde collegi ſummum cacumen iſtius montis Carpathici ad Mill. Germ. à radicibus ſuis in altum exſurgere, & ad ſupremam uſque aëris regionem, ad quam Venti non aſcendunt, pertingere. Expleſi in eâ ſummitate Sclopetum: quod non majorem ſonitum primò præ ſe tulit, quàm ſi ligillum vel bacillum confregiſſem; poſt intervallum autem temporis murmur prolixum intonuit, inferioreſque montis partes, convalles & ſylvas opplevit. Deſcendendo per nives annoſas intra convalles, cùm iterum Sclopetum exonerarem, major & horribilior fragor, quàm ex tormento capaciſſimo ingens exoriebatur: hinc verebar ne totus mons concuſſus mecum corrueret. Duravitque hic ſonus per ſemiquadrantem horæ uſque dum abſtruſiſſimas cavernas penetrâſſet, ad quas aër undique multiplicatus reſiliit. ——In his celſis montibus, plerumque vingit grandinatve mediâ æſtate, quoties nempe in ſubjectâ & vicinâ planitie pluit, uti hoc ipſum expertus ſum. Nives diverſorum annorum ex colore & cortice duriore dignoſci poſſunt. Varen. Geogr. Gen. l. 1. c. 19. Prop. ult.

This Story being diverting, and containing divers Things remarkable, I have choſen to note the Whole of it (although ſomewhat long) rather then ſingle out the Paſſages only which relate to the diminiſhing of the Sound of his Piſtol by

Omnipotent and Infinitely Wise God could contrive, and make such a fine Body, such a Medium, so susceptible of every Impression, that the Sense of Hearing hath occasion for, to empower all Animals to express their Sense and Meaning to others; to make known their Fears, their Wants, their Pains and Sorrows in melancholick Tones; their Joys and Pleasures in more harmonious Notes; to send their Minds at great Distances (*cc*), in a short Time (*dd*),

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by the Rarity of the Air at that great Ascent into the Atmosphere; and the magnifying the Sound by the Polyphonisms or Repercussians of the Rocks, Caverns, and other Phonoamptick Objects below in the Mount.

But 'tis not the Air alone that is capable of the Impressions of Sound, but the Water also, as is manifest by striking a Bell under Water, the Sound of which may plainly enough be heard, but it is much duller, and not so loud; and it is also a fourth deeper, by the Ear of some great Judges in Musical Notes, who gave me their Judgments in the Matter. But *Mersenne* saith, a Sound made under Water, is of the same Tone or Note, if heard under Water; as are also Sounds made in the Air, when heard under Water. *Vid. Mersen. Hydraul.*

Having mentioned the hearing of Sounds under Water, here is another Curiosity worth mentioning, that also farther proves Water to be susceptible of the Impressions of Sound, *viz. Divers* at the Bottom of the Sea, can hear the Noises made above, only confusedly. But, on the contrary, those above cannot hear the *Divers* below. Of which an Experiment was made, that had like to have been fatal: One of the *Divers* blew an Horn in his Diving-Bell, at the Bottom of the Sea; the Sound whereof (in that compressed Air) was so very loud and irksome, that stunned the *Diver*, and made him so giddy, that he had like to have dropt out of his Bell, and to have been drowned. *Vid. Sturmii Colleg. Cur. Vol.* 2. *Tentam.* 1.

(*cc*) As to the Distance to which Sound may be sent, having some doubt, whether there was any Difference between the Northern and Southern Parts, by the Favour of my learned and illustrious Friend Sir *Henry Newton*, her late Majesty's Envoy at *Florence*; I procured some Experiments to

Time (*dd*), in loud Boations; or to expreſs their Thoughts near at hand with a gentle Voice, or in ſecret Whiſpers! And, to ſay no more, who leſs than the ſame moſt Wiſe and Indulgent Creator, could

be made for me in *Italy*. His moſt Serene Highneſs the *Great Duke*, was pleaſed to order great Guns to be fir'd for this purpoſe at *Florence*, and Perſons were appointed on purpoſe to obſerve them at *Leghorne*, which they compute is no leſs than 55 Miles in a ſtrait Line. But notwithſtanding the Country between being ſomewhat hilly and woody, and the Wind alſo was not favouring, only very calm and ſtill, yet the Sound was plainly enough heard. And they tell me, that the *Leghorne* Guns are often heard 66 Miles off, at *Porto Feraro*; that when the *French* bombarded *Genoa*, they heard it near *Leghorne*, 90 Miles diſtant; and in the *Meſſina Inſurrection*, the Guns were heard from thence as far as *Auguſta* and *Syracuſe*, about 100 *Italian* Miles. Theſe Diſtances being ſo conſiderable, give no reaſon to ſuſpect, that Sounds fly as far, or nearly as far, in the Southern, as in the Northern Parts of the World, notwithſtanding we have a few Inſtances of Sounds reaching farther Diſtances. As Dr. *Hearn* tells us of Guns fired at *Stockholm* in 1685, that were heard 180 *Engliſh* Miles. And in the *Dutch* War, 1672, the Guns were heard above 200 Miles. *Vid. Phil. Tranſ.* No. 113. Alſo there is this farther Reaſon of Suſpicion, that the *Mercury* in the *Barometer* riſeth higher without than within the Tropicks, and the more Northerly, ſtill the higher, which may increaſe the Strength of Sounds, by *Note* (*bb*).

(*dd*) As to the Velocity of Sounds, by Reaſon the moſt celebrated Authors differ about it, I made divers nice Experiments my ſelf, with good Inſtruments; by which I found, 1. That there is ſome, although a ſmall Difference in the Velocity of Sounds, with or againſt the Wind: which alſo is, 2. Augmented or diminiſhed by the Strength or Weakneſs of the Wind. But that nothing elſe doth accelerate or retard it, not the Differences of Day or Night, Heat or Cold, Summer or Winter, Cloudy or Clear, Barometer high or low, &c. 3. That all kinds of Sounds have the ſame Motion, whether they be loud or languid, of Bells, Guns, great or ſmall, or any other ſonorous Body. 4. That they fly equal Spaces in equal Times. Fifthly and Laſtly, That the Mean of their Flight is at the Rate of a Mile in 9 half Seconds and a quarter, or 1142 Feet in one Second of Time. *Vid. Phil. Tranſ. Ibid.*

(*ee*) *Timothy*

ould form ſuch an OEconomy, as that of Melody nd Muſick is; That the *Medium* ſhould (as I ſaid) readily receive every Impreſſion of Sound, and onvey the melodious Vibration of every muſical ring, the harmonious Pulſes of every animal oice, and of every muſical Pipe; and the Ear be well adapted, and ready to receive all theſe Im- eſſions, as the *Medium* to convey them: And laſt-, that by Means of the curious Lodgment, and oſculations of the *auditory Nerves* before-men- oned, the Orgaſms of the Spirits ſhould be allay'd, d Perturbations of the Mind, in a great Meaſure ieted and ſtilled (*ee*): Or to expreſs it in the Words

(*ee*) *Timothy* a Muſician could excite *Alexander the Great* to ms with the *Phrygian* Sound, and allay his Fury with ano- r Tone, and excite him to Merriment. So *Ericus* King of *mark*, by a certain Muſician, could be driven to ſuch a Fury, to kill ſome of his beſt and moſt truſty Servants. More this Power of Muſick over the Affections, may be ſeen in , *Kirch. Phonurg. L. 2. Sect.* 1. Alſo in *Iſ. Voſſius de Poëma- cantu, & Rythmi viribus.*

And not only upon the Affections, but alſo on the Parts of Body, Muſick is able to exert its Force, as appears from *Gaſcoigne* Knight, *Cui Phormingis ſono audito Veſica ſtatim ad nam reddendam vellicabatur.* Such another we have in No. *Ephem. Nat. Curioſ. Obſerv.* 134. Alſo *Morhoff de Scyph. vitr. cert. human, vocis ſonum fracto:* where there is not only the count of the *Dutchman* at *Amſterdam*, one *Nich. Peter*, that ake Romer-Glaſſes with the Sound of his Voice; but alſo vers other Inſtances of the Powers and Effects of Sound. t to the Story of the *Gaſcoigne* Knight, Mr. *Boyle*, from *Sca- r*, adds a pleaſant Paſſage, That one he had diſobliged, be even with him, cauſed at a Feaſt, a Bag-pipe to be ayed, when he was hemmed in with the Company; which ade the Knight be-piſs himſelf, to the great Diverſion of e Company, as well as Confuſion of himſelf. *Boyle's Eſſay the Effect of Lang. Motion.* In the ſame Book are other atters that may be noted here. One whoſe Arm was cut f, was exceedingly tormented with the diſcharge of the great

great Guns at Sea, although he was at a great Diſtance on Land. And a great Ship-Commander obſerved his wounded Men, with broken Limbs, ſuffered in like manner at the Enemies Diſcharges. An ingenious Domeſtick of his own would have his Gums bleed at the tearing of Brown-Paper. And an ingenious Gentleman of Mr. *Boyle*'s Acquaintance confeſſed to him, that he was inclined to the Knight of *Gaſcoigne*'s Diſtemper, upon hearing the Noiſe of a Tap running. To dancing to certain Tunes, of Perſons bit with the *Tarantula*, he was aſſured by an ingenious Acquaintance at *Taren* who ſaw ſeveral, among the reſt a Phyſician, affected with that Diſtemper. And many other Accounts of this kind ſeemingly credible, are related in *Morhoff*, *Kircher*, and many others; although Dr. *Cornelio* queſtions the Matters of Fact relating to the Cure of the *Tarantula*-bite, *in Phil. Tranſ.* N° 82. Mr. *Boyle* alſo ſaith, a ſober Muſician told him, he could make a certain Woman weep, by playing one Tune, which others would be little affected at. And he ſaith, that himſelf had a kind of ſhivering at the repeating two Verſes in *Lucan*. And I add, that I very well know one to have a ſort of Chill about his *Præcordia* and Head, upon reading or hearing the 53d Chapter of *Iſaiah*; as alſo *David*'s Lamentations for *Saul* and *Jonathan*, 1 *Sam.* 1.

Neither are our own Minds and Bodies only affected with Sounds, but inanimate Bodies are ſo alſo. Of which many Stories may be met with in *Kircher*, particularly a large Stone that would tremble at the Sound of one particular Organ Pipe; in *Morhoff* alſo, who among many other Relations to this, *Memini cum ipſi* [*clariſ. Williſio*] *de experimento Vitri per vim Ictûs narrarem, ex eo audiviſſe, quòd in ædibus Muſicis ſibi quæ aliquoties collapſum pavimentum fuerit; quod ipſe ſonis continuis adhibere non dubitavit*, Morhoff. cap. 12. *Merſenne* alſo, among many Relations in his *Harmon.* and other Books, tells a more probable Story, of a particular Part of Pavement, that would ſhake, as if the Earth would open, when the Organ played, than what he relates about *Antipathy*, in his *Quæſt. Comment. in Geneſ.* viz. That the Sound of a Drum made of a Wolf's Skin, will break another made of Sheep's Skin. That Hens will fly at the Sound of an Harp ſtrung with Fox-Gut-Strings, and more to the ſame purpoſe. Mr. *Boyle* alſo, in his laſt cited Book tells us, Seats will tremble at the Sound of Organs; and that he hath felt his Hat to do ſo under his Hand, at certain Notes both of Organs, and in Diſcourſe, that he tried an Arch that would anſwer to C faſola, and had done ſo an 100 Years; and that an experienced Builder told him any well-built Vault will anſwer ſome deter-

Words of the laſt-cited famous Author (*ff*), "That Muſick ſhould not only affect the Fancy with Delight, but alſo give Relief to the Grief and Sadneſs of the Heart; yea, appeaſe all thoſe turbulent Paſſions, which are excited in the Breaſt by an immoderate Ferment, and Fluctuation of the Blood".

And now, who can reflect upon all this curious Apparatus of the *Senſe of Hearing*, and not give the Great Creator his due Praiſe! Who can ſurvey this admirable Work, and not as readily own it to be the Work of an Omnipotent, and Infinite-Wiſe and Good GOD (*gg*), as the moſt artful Melodies we hear, are the Voice or Performances of a living Creature!

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the Note. And at *Enſbury-Houſe* near *Barking*, I my ſelf diſcovered the Porch, (having firm Brick-Walls,) not only to ſound when ſtruck on the Bottom, but alſo to give almoſt as loud a Sound, when I ſounded the ſame Note with my Voice.

(*ff*) *Willis*, ubi ſupra.

(*gg*) *Ille Deus eſt——qui non calamo tantum cantare, & agreſte, ſine inconditum carmen ad aliquam tantùm oblectationem modulari poſſit, ſed tot artes, tot vocum varietates, tot ſonos, alios ſpiritu noſtro, alios externo cantu edituros commentus eſt.* Senec. de Benef. l. 4. c. 6.

CHAP. IV.

Of the Senſe of Smelling.

THIS Senſe I ſhall diſpatch in leſs Compaſs than the two laſt, becauſe its Apparatus (although ſufficiently grand and admirable, yet) is not ſo multiplicious as of the Eye and Ear; it being ſufficient in this Senſe, that the odoriferous Effluvia of Bodies

Bodies (*a*) can have an eaſy, free Paſſage to the olfactory Nerves, without the Formalities of Refractions, and other Preparations neceſſary to the Perfection of the two former Senſes. Accordingly the All-wiſe Creator hath made ſufficient Proviſion for the Reception of Smells, by the Apertures of the Noſtrils (*b*); made not of Fleſh, or Bone, but cartilaginous, the better to be kept open, and withal, to be dilated or contracted, as there is Occaſion: For which Service it hath ſeveral proper and curious Muſcles (*c*).

And foraſmuch as it is by Breathing (*d*), that the odorant Particles are drawn in, and conveyed to the Senſory; therefore there is a very wiſe Proviſion made in the *Laminæ*, with which the upper Part of the Noſe is barricaded, which ſerve to two excellent Uſes: Partly, to fence out any noxious Subſtances from entering the breathing Paſſages in

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(*a*) A Piece of *Ambergreaſe* ſuſpended in a Pair of Scales that would turn with a very ſmall Part of a Grain, loſt nothing of its Weight in 3 Days and half; neither did *Aſſafœtida* in 5 Days and half: But an Ounce of *Nutmegs* loſt 5 Grains and half in 6 Days; and *Cloves* 7 Grains and four fifths. *Boyle's Subtil. of Effluv.* c. 5.

(*b*) *Nares, eò quod omnis Odor ad ſuperiora fertur, rectè ſurſum ſunt. Et quod Cibi & Potionis judicium magnum earum eſt, non ſine causa vicinitatem Oris ſecutæ ſunt.* Cic. de Nat. Deor. *l.* 2. *c.* 56.

(*c*) Had not the Contriver of Animal Bodies been minded that his Work ſhould have all the Signatures of Accuracy, this Senſe might have been performed with a bare Aperture of the Noſe; but that nothing might go imperfect out of his Hand, he hath made a Part of the Noſe eaſily moveable, and given a Set of Muſcles to lift up, and open and ſhut the Noſtrils; and ſo adjuſt it to every Occaſion of this Senſe.

(*d*) *Odorem non aliùd, quàm infectum Aëra, intelligi poſſe.* Plin. Nat. Hiſt. l. 9. c. 7.

(*e*) For

ur Sleep, or when we cannot be aware (*e*); and rtly, to receive the Divarications of the *olfactory erves*, which are here thick ſpread, and which by theſe Means meet the Smells entring with e Breath, and ſtriking upon them.

And accordingly, the more accurate this Senſe is any Animal, the longer we may obſerve thoſe *aminæ* are; and more of them in Number folded , and crouded together, to contain the more rvous Filaments, and to detain and fetter the oriferous Particles in their Windings and Turngs.

And an admirable Proviſion this is, which the eat Creator hath made for the Good of Brute eatures (*f*); the chief Acts of many of whoſe ves are perform'd by the Miniſtry of this Senſe. Inſects, and many other Creatures, it is of great ſe in the Propagation of their Kind; as particurly in helping them to ſafe and convenient Places r the Incubation of their Eggs, and breeding up their

(*e*) For a further Guard againſt the Ingreſs of noxious nings, the *Vibriſſi*, or Hairs placed at the Entrance of the oſtrils ſerve, which, in ſome Meaſure ſtop the Entrance of nings improper, or, however, give Warning of them; but the ſame Time allow an eaſy Paſſage to the Breath and dours.

(*f*) *Multò præclarius emicat* [*Olfactus*] *in brutis animalibus, quàm homine: iſta namque hoc ſolo indice, herbarum, aliorumque corporum ius ignotorum virtutes certiſſimè dignoſcunt, quin & victum ſuum ſentem, vel in abſtruſo poſitum, Odoratu venantur, ac facillimè invegant. Quòd autem minus ſagaces ſunt hominum nares, illud non faltatis hujus abuſui (prout nonnulli volunt) aſcribi debet, verùm in uſâ eſt ipſius Organi defectus: hoc enim circa victûs humani criteria bi ratio, & intellectus adſunt) non ita accuratum requiritur: Propreà enim inferiores potentiæ in homine, à naturâ minus perfectæ exſunt, ut ſuperiorum cultui & exercitio relinqueretur locus.* Willis de nim. Brut. cap. 13.

(*g*) Thus

their Young. Others are by the Accuracy of this Sense, of Use to Mankind, which would be otherwise of little or no Use (*g*). And most of the irrational Animals, Birds, Beasts, and creeping Things, do, by their Smell, find out their Food; some at great Distances, and some at Hand. With what Sagacity do some discover their Food in the midst of Mud and Dirt (*h*)? With what Curiosity do the herbaceous Kind pick and chuse such Plants as afford them wholsome Food, or sometimes such as are Medicinal (*i*), and refuse such as would hurt and destroy them? And all by the Help principally, if not only, of the Smell, assisted by its near Ally the Taste. Of which I shall in the next Place speak very briefly.

(*g*) Thus the chief Use of Hounds is to hunt; and other Dogs, to be a Watch and Guard to our Houses by Night. For which Services (particularly in Hounds) their *Olfactory Nerves* are not only remarkably large, (like as they are in other Brutes,) but their Branches and Filaments are, in the *Lamina* of the Nostrils, both more and larger than I have seen in any other Creature whatsoever. Also there are more Convulsions of the *Lamina* than I ever remember to have found in any other Animal.

The Sagacity of Hounds is prodigious; of which see an Instance in *Book* IV. *Chap.* 11. *Note* (*hhh*).

(*h*) See *Book* VII. *Chap.* 2. *Note* (*e*).

(*i*) *Vide Plin. Hist. Nat.* l. 8. cap. 27. *Quæ animalia quas herbas ostenderunt.*

CHAP

CHAP. V. *Of the Taſte* (*a*).

IN this, as in the laſt Senſe, we have an *Apparatus* abundantly ſufficient to the Senſe; Nerves riouſly divaricated about the Tongue (*b*), and outh, to receive the Impreſſions of every Guſto; d theſe Nerves guarded with a firm and proper egument to defend them from Harms; but withal, perforated in the papillary Eminences, as to give free Admiſſion to Taſtes. But

(*a*) Τὰ δ' εἴδη τῶν χυλῶν, &c. *Saporum genera,* —— *dulcis, pinguis, auſterus, acerbus, acris, ſalſus, amarus, acidus.* Theophr. de Cauſ. Plant. *l.* 6. *c.* 1. What may be the Cauſe of the difference of Taſtes, he ſaith is hard to aſſign, πότερον γὰρ τοῖς πάθεσι, &c. *Utrum affectionibus Senſuum*——*an figuris, quibus ſinguli conſtant, ut* Democritus *cenſet.* id. ib. Δημόκριτος δὲ, &c. *Democritus*——*dulcem eſſe ſaporem qui rotundus; acerbum qui figurâ ſignâ; aſperum qui multis angulis,* &c. id. ib. &c. But of the Diverſities and Cauſes of Taſtes, ſee Dr. *Grew, Lect.* 6. and *Dr. Willis de Anim. Brut.* c. 12.

(*b*) *Intellectus Saporum eſt cæteris in primâ linguâ: Homini, & in Palato.* Plin. l. 11. c. 37.

The Opinions of Anatomiſts concerning the Organ of *Taſte*, are various. *Bauhin, T. Bartholin, Bartholette, Veſlinge, Deuſinge*, &c. place it in the laxer, fleſhy Parts of the Tongue. Our famous *Wharton*, in the Gland at the Root of the Tongue: *Laurentius* in the thin Tunick covering the Tongue; but the learned *Malpighi* with great Probability concludes, becauſe the outward Cover of the Tongue is perforated, under which the papillary Parts, (of which Mr. *Cowper* hath very good Cuts in his *Anat. Tab.* 13.) that in theſe the Taſte lieth. *Malpighi*'s Words are, *Quare cùm dictis meatibus inſignibus occurrant papillaria corpora, probabilius eſt in his ultimo, ex ſubintranti ſapido humore titillationem, & mordicationem quandam fieri, quæ Guſtum efficiat.* Malpig. Op. Tom. 2. De Linguâ, pag. 18.

Præcipuum ac ferè ſolum Guſtatûs organon eſt Lingua; cui aliquatenus ſubobſcurè tamen Palatum, & ſuperior Gulæ pars conſentiunt: in omnibus verò fibræ nervoſæ immediatæ ſenſionis inſtrumenta ſunt. Quare obſer-

But I ſhall ſay no more of this Senſe; only a Word or two of its Conſent with the Smell, and the Situation of them both: Their Situation is in the moſt convenient Place imaginable, for the Diſcharge of their Offices; at the firſt Entrance (*c*) in the Way to the grand Receptacle of our Food and Nouriſhment; to ſurvey what is to be admitted therein; to judge between what is wholſome and fit for Nouriſhment, and what is unſavoury and pernicious. And for this End, the All-wise Creator ſeems to have eſtabliſhed a great Conſent between the Eye, the Noſe, and Tongue, by ordering the Branches of the ſame Nerves (*d*), to each of thoſe three Parts; as alſo indeed, to divers other Parts of the Body, which I may have Occaſion to mention in a more proper Place (*e*). By which Means, there is all the Guard that can be, against pernicious Food; foraſmuch, as before it is taken

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obſervare eſt, Linguam præ aliâ quâvis parte inſigniter fibroſam & etiam texturâ valdè perosâ conſtare, *in eum nempe finem, ut partic*rei ſapidæ copioſiùs ac penitiùs intra Senſorii meatus admittantur— *Nervi autem qui fibris Linguæ denſiſſimè intertextis famulantur,* ſaporum impreſſiones τῷ πρώτῳ αἰσθητηρίῳ *communicant, ſunt— Nervi è paribus tum quinto, tum nono; & ubique cum densâ propa*num ſerie per totam ejus compagem diſtributi. Willis ibid.

(*c*) *Guſtatus, qui ſentire eorum quibus veſcimur genera debet, habe*tat in ea parte Oris, quâ eſculentis & poculentis iter natura patefa Cic. de Nat. Deor. l. 2. c. 56. *Vide quoque ſupra.* Note (*b*) Chap. 4.

(*d*) *Multa hujus* [quinti Paris] *Nervi propagines Maſticationi* peri deſtinantur; ideoque quoniam alimenta ingerenda non modò Guſtû *aſt etiam Olfactûs & Visûs examen ſubire debent, ab eodem Nervo ejus rami ad Palatum & Fauces miſſi, Manducationis negotium per*ſunt, propagines aliæ, velut exploratrices, ad Nares & Oculos ferun*tur* nempe ut iſthæc aliorum ſenſuum organa, etiam ad objecta Guſtûs m*elius dignoſcenda probationum auxiliis quibuſdam inſtruantur.* Will Nerv. Deſcrip. & Uſus. *cap.* 22.

(*e*) See *Book* V. *Chap.* 8.

(*a*) *Ma*

nto the Stomach, it is to undergo the Trial of hree of the Senſes; the Scrutiny of the Eye, the rict Surveyor of its outward Appearance; and e Probation of the Smell and Taſte, the two ſe-ereſt Judges of its natural Conſtitution and Com-oſition.

CHAP. VI. *Of the Senſe of Feeling* (*a*).

HAVING ſpent ſo much Time upon the other Senſes, and therein given ſuch ample Proofs the Infinite Creator's Wiſdom; I ſhall but briefly ke Notice of two Things relating to this laſt nſe.

One is its Organ, the Nerves. For as all Senſation

(*a*) *Malpighi* is of this Opinion, that as *Taſte* is performed the *Papillæ* in the Tongue, ſo is *Feeling* by ſuch like *Papillæ* der the Skin. From ſeveral Diſſections, and other Obſerions, he thus concludes, *Ex his & ſimilibus videbatur animus ndè certior redditus, earundem Papillarum pyramidalium copiam, s aliàs in Linguâ deſcripſi, in locis præcipuè acquiſitiori Tactui dis reperiri, eodem progigni nervoſo & cuticulari corpore, ſimulque circvolvi reticulari involucro, & extimam cuticulam, veluti ultimum minum attingere. ——Microſcopio quilibet in manûs dorſo pro ſudore icia quædam miro ordine diſperſa intueri poteſt, circa quæ frequentia dam capitula aſſurgunt; hæc vero ſunt Papillarum fines, dum à e aſſurgentes interpoſitum ſuperant rete, ſimulque extimam cuticu. Hæc repetitis ſectionibus deprehendi; ex quibus non improbabiliter ucam, ſicuti ex elatoribus——papillis——in Lingua, Guſtûs Orgon elicitur,——ita ex copioſa harum Papillarum congerie——in anis, ubi maxime animalia Tactûs motione afficiuntur,——adæquatum Tactûs organum ſufficienter haberi.* Malpig. de extern. act. Org. *p.* 26. *Conſul. quoque ejuſd. Vit.* p. 28.

These Obſervations of *Malpighi*, our late curious and diligent Mr. *Cowper* hath confirmed, and given us very elegant cuts both of the Skin, and the *Papillæ*, and the Nerves, glands, &c. under it, from Microſcopical Obſervations. *Vide Cowper's Anat. Introd.* and *Tab.* 4.

tion is performed by the Nerves (*b*), and indeed the other Senſes (performed by Nerves) are a Kind of Feeling; ſo is this Senſe of *Feeling* performed by Nerves likewiſe, ſpread in the moſt incomparable, curious Manner throughout the whole Body. But to deſcribe their Origin in the Brain, and Spinal-Marrow, their Ramifications to all the Parts; their Inoſculations with one another; and other Matters; whereby not only the Senſe of *Feeling* is performed, but alſo animal Motion, and admirable Conſent and Harmony of all the Parts of the Body is effected: [To deſcribe, I ſay, theſe Things,] would take up too much Time, and I have already, and ſhall, as I go along, give ſome Hints thereof.

The other Thing I ſhall take Notice of, is, the Diſperſion of this Senſe throughout the Body, both without and within. The other Senſes, I have obſerv'd, are ſeated in the very beſt Place for the Relief and Comfort, the Guard and Benefit of the Animal. And foraſmuch as it is neceſſary to the Being and Well-being of the Body, that every Part ſhould be ſenſible of Things ſafe, or Things prejudicial to it ſelf; therefore, it is an admirable Contrivance of the Great Creator, to diſperſe this Senſe of *Feeling* throughout every Part (*c*); to diſtinguiſh between

(*b*) Although the Eye be the uſual Judge of Colours, yet ſome have been able to diſtinguiſh them by their Feeling. *Quidam fuit qui venit ad M. Duc.* Hetruriæ *aulam qui colores per Tactum cognoſcebat. Pro experimento velum ſericum, uniformiter textum, & pluribus coloribus tinctum, offerebatur, & veraciter de colore ſingulis partibus judicabat.* Grimald. de Lum. & Col. prop. 43. ſect. 59.

(*c*) *Tactus autem toto corpore æquabiliter fuſus eſt, ut omnes ictus omneſque nimios & frigoris, & caloris appulſus ſentire poſſimus.* Cic. *ubi ſupra.*

Tactus

between Pleaſure and Pain; Things ſalutary, and Things hurtful to the Body.

Thus in the five Senſes of Animals, we have an OEconomy worthy of the Creator, and manifeſtly demonſtrating his Power, Wiſdom and Indulgence. For whether we conſider the Mechaniſm of the Organs, or the great Uſe and Convenience of each Senſe, we find it noble and grand, curious and artificial; and every way worthy of its Infinite Maker, and beyond the Wit and Power of any Thing but a GOD: And therefore we muſt even deny our Senſes, by denying them to be God's handy-work.

And now from thoſe chief Machines of Animal Performances and Enjoyments, the five Senſes; let us paſs to another Thing in common to all the ſentive Creatures, which is Reſpiration.

Tactus ſenſus omnibus eſt, etiam quibus nullus alius; nam & Oſtreis, & terreſtribus Vermibus quoque. Exiſtimaverim omnibus ſenſum & ſtatûs eſſe. Cur enim alios alia ſapores appetunt? in quo vel præcipua naturæ architectio. Plin. Nat. Hiſt. l. 10. c. 71.

CHAP. VII. *Of Reſpiration.*

OF all the Acts of Animal Life, this is one of the chief, and moſt neceſſary. For whatſoever hath Animal Life, hath alſo the Faculty of Reſpiration, or ſomewhat equivalent thereto (*a*). Indeed

(*a*) The Uſes aſſign'd to *Reſpiration* by all the Anatomiſts before *Malpighi*'s Diſcoveries of the Structure of the Lungs, are ſo various, and many of them ſo improbable, that it would be frivolous to recount them. But the more eminent modern Anatomiſts aſſign theſe Uſes. *Willis* thus ſums up his Opinion,

deed ſo congenial is this with Life, that *Breath* and *Life* are in Scripture Phraſe and Common Speech

nion, *Præcipua Pulmonum functio, & uſus ſunt, ſanguinem & aerem per totas partium compages, intimoſque receſſus, atque ductus quoſque minutiſſimos traducere, & ubique invicem committere; in eum nempe finem, ut ſanguis venoſus à circuitu redux, & chymo recenti dilutus —— tum perfectius miſceatur & velut ſubigatur, tum potiſſimùm ut ſecundum omnes ſuas partes ab aëre nitroſo de novo accendatur.* Pharmaceut. P. 2. S. 1. C. 2. Sect. 2. *Mayow* ſaith rightly, that one grand Uſe of *Expiration* is, *Ut cum aëre expulſo, etiam vapores è ſanguine exhalantes, ſimul exſufflentur.* And as for *Inſpiration*, that it conveyeth a nitro-aerial Ferment to the Blood, to which the Animal-Spirits are owing, and all Muſcular-Motion. *Mayow de Reſpir.* p. 22, *&c. mea Edit.*

Somewhat of the Opinion of theſe two laſt cited, if I miſtake not (it being long ſince I read their Tracts, and have them not now at Hand,) were *Ent*, *Sylvius*, *Swammerdam*, *Diemerbroek*, and my Friend Mr. *Ray*, in an unpubliſhed Tract of his, and his Letters now in my Hands.

But our Dr. *Thurſton*, for good Reaſons, rejects theſe from being principal Uſes of *Reſpiration*, and thinks, with great Reaſon, the principal Uſes to be to move, or paſs the Blood from the right to the left Ventricle of the Heart. Upon which account Perſons hanged, drowned, or ſtrangled by Catarrhs, ſo ſuddenly die, namely, becauſe the Circulation of their Blood is ſtopped. For the ſame Reaſon alſo it is that Animals die ſo ſoon in the Air-Pump. Among other Proofs he inſtanceth in an Experiment of Dr. *Croon*, *Profeſſ. Greſh.* which he made before our *R. S.* by ſtrangling a Pullet, ſo that not the leaſt Sign of Life appear'd; but by blowing Wind into the Lungs through the *Trachea*, and ſo ſetting the Lungs a-playing, he brought the Bird to Life again. Another Experiment was once tried by Dr. *Walter Needham*, before Mr. *Boyle*, and others at *Oxford*, by hanging a Dog, ſo that the Heart ceaſed moving. But haſtily opening the Dog, and blowing Wind into the *Ductus Pecquetianus*, he put the Blood in Motion, and by that Means the Heart, and ſo recovered the Dog to Life again. *V. Thurſton de Reſpr. Uſ. p.* 62 and 63. *mea Edit.*

Such an Experiment as Dr. *Croon*'s my Friend, the late juſtly renowned Dr. *Hook* ſhewed alſo our *R. S.* He cut away the *Ribs*, *Diaphragm*, and *Pericordium*, of a Dog; alſo the Top of the Wind-Pipe, that he might tie it on to the Noſe of a Pair

Pair of Bellows; and by blowing into the Lungs, he reſtored the Dog to Life; and then ceaſing blowing, the Dog would ſoon fall into dying Fits; but by blowing again, he recovered; and ſo alternately would die, and recover, for a conſiderable Time, as long, and often as they pleaſed. *Philoſ. Tranſ.* No. 28,

For the farther Confirmation of Dr. *Thurſton*'s Opinion, the ingenious Dr. *Muſgrave* cut off, and cloſe ſtopped up the Wind-Pipe of a Dog with a Cork, and then threw open the *Thorax*; where he found the Blood ſtagnating in the *Lungs*, the *Arteria Pulmonaris*, the *Right Ventricle* and *Auricle* of the *Heart*, and the two great Trunks of the *Cava*, diſtended with Blood to an immenſe Degree; but at the ſame Time, the *Vena Pulmonaris*, the *Left Ventricle* and *Auricle* of the *Heart* in a manner empty, hardly a ſpoonful of Blood therein. *Philoſ. Tranſ.* No. 240. Or both the Experiments may be together met with in *Lowth. Abridg. Vol.* 3. *p.* 66, 67.

This Opinion of our learned *Thurſton*, the late learned *Etmullerus* eſpouſed, who being Particular in reckoning up the Uſes of Reſpiration, I ſhall therefore the more largely cite him. Reſpiration, ſaith he, ſerves, 1. *Ad Olfactum.* 2. *Ad Creatum & Sputationem.* 3. *Ad Oſcitationem, Tuſſim, Sternutationem, Emunctionemque.* 4. *Ad liquidorum Sorbitionem, Suctionemve.* 5. *Ad Loquelam, Cantum, Clamorem, Riſum, Fletum, Flatum, &c.* 6. *Ad fæcum Alvi, Urinæ, Fœtûs Molæve, necnon Secundinarum exclusionem.* 7. *Ad promovendi Ventriculi, Inteſtinorum, Lacteorumque vaſorum, &c. contenta.* 8. *Ad halitus aqueos Sanguinis è pulmonibus, aëris ope, exportandos.* 9. *Ad Diapnoën.* 10. *Ad exactiorem Chyli, Lymphæque, necnon Sanguinis——miſcelam.* 11. *Ad concilliandum ſanguini——coccineam rubedinem, &c.* 12. *Nec morosè negabimus, aërem——pulmones, & ſanguinem illos tranſcurrentem, vitaus calida reddere, &c.* 13. *Quòd denique aër ſanguini ſingulis Reſpirationibus aliquantillâ ſui parte, admixtus, pauciſſimas quaſdam in ſpirituum animalium elaboratione particulas ſimul contribuat.* All theſe Uſes, although of great Conſequence, yet he thinks rather conduce to the *Well-being*, than the Being of the Animal; becauſe without any of them, the Animal would not ſo ſpeedily die, as it doth by Strangling, or in the Air-Pump. He therefore aſſigns a 14th, and the principal Uſe of Reſpiration to be, *For the paſſing of the Blood through the Lungs, that is thrown into them by the Heart.* Etmull. Diſert. 2. cap. 10. ſect. 15, & 16.

But the late Dr. *Drake*, with great Ingenuity and Addreſs, (like a Perſon ſo conſiderable for his Years, as he was in his Time,) not only eſtabliſh'd this Notion of Reſpiration, but alſo carries it farther, making it the true Cauſe of the *Diaſtole*

Speech taken as ſynonymous Things, or at leaſt, neceſſary Concomitants of one another. *Moſes* (*b*) expreſſeth Animal-Life, by [*The Breath of Life.*] Saith he, *Gen.* vii, 21. 22. *All Fleſh that moveth on the Earth, Fowl, Cattle, Beaſt, creeping Things,*

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of the Heart; which neither *Borelle*, *Lower*, or *Cowper*, much leſs any before thoſe great Men, have well accounted for. That the Heart is a Muſcle, is made evident beyond all Doubt by Dr. *Lower*. And that the Motion of all Muſcles conſiſts in Conſtriction, is not to be doubted alſo. By which Means the *Syſtole* is eaſily accounted for. But foraſmuch as the Heart hath no *Antagoniſt-Muſcle*, the *Diaſtole* hath puzzled the greateſt Wits. But Dr. *Drake* with great Judgment, and much Probability of Reaſon, maketh the Weight of the Incumbent Atmoſphere to be the true *Antagoniſt* to all the Muſcles, which ſerve both for ordinary Inſpiration, and the Conſtriction of the Heart. The Particulars of his Opinion may be ſeen in his *Anatomy*, *l.* 2. *c.* 7. And in *Philoſ. Tranſ.* No. 281.

And I remember when I was at the Univerſity, my moſt ingenious and learned Tutor Dr. *Wills*, when he read Anatomy to us, was of Opinion, That the Lungs were blown up by the Weight of the incumbent Air, and repreſented the Manner of Reſpiration in this manner, *viz.* He put a Bladder into a Pair of Bellows, turning back the Neck of the Bladder, and tying it faſt, ſo that no Air might enter in between the Bladder and Bellows. This being done, when the Bellows were opened, the Bladder would be blown up by the Weight of the incumbent Air; and when ſhut, the Air would be thereby preſſed forcibly out of the Bladder, ſo as to blow the Fire. This Experiment I take Notice of here; becauſe (beſides the Illuſtration it gives to Reſpiration) that great *Genius* ſeems to have had a truer Notion of this *Phænomenon*, than was very Common then, *viz.* about the Year 1677, or 78; as alſo, becauſe I have in ſome Authors met with the ſame Experiment, without mention of Dr. *Wills*, whoſe I take it to have been.

Another Uſe of great Conſideration, the already commended Dr. *Cheyne* aſſigns; namely, to Form the claſtick Globules of which the Blood principally conſiſts, without which there would be a general Obſtruction in all the capillary Arteries. *Cheyne's Philoſophical Princ. of Natur. Religion*; or *Harris's Lex. Tech. in Lungs.*

(*b*) *Gen.* ii. 7.—vi. 17. and vii. 15.

(*c*) Be-

Things, and Man; all in whoſe Noſtrils was the Breath of Life in the dry Land died. So the Pſalmiſt, *Pſal.* civ. 29. *Thou takeſt away their Breath, they die.* So grand an Act therefore in Common to all Animals, may juſtly deſerve a Place in this Survey of the Works of GOD in the Animal-Kingdom.

And here I might launch out into an ample Deſcription of all the Parts miniſtring to this neceſſary Act, and ſhew the curious Contrivance, and artificial Structure of them; but a tranſient View ſhall ſuffice. I might begin with the outward Guards, the Noſe and Mouth; but theſe have been already touched upon. But the exquiſite Mechaniſm of the *Larynx*, its Variety of Muſcles, its Cartilages, all ſo exquiſitely made for the Purpoſe of Reſpiration, and forming the Voice (*c*), are very admirable: And no

(*c*) Becauſe it would be endleſs to ſpecify the curious Mechaniſm of all the Parts, concurring to the Formation of the Voice; I ſhall therefore for a Sample note only two Things: 1. There are thirteen Muſcles provided for the Motion of the five Cartilages of the *Larynx*. *Gibſ. Anat. l.* 2. *c.* 14. a Sign of the careful and elaborate Proviſion that is made for the Voice. 2. It is a prodigious Faculty of the *Glottis*, in contracting and dilating it ſelf with ſuch Exquiſiteneſs, as to Form all Notes. For (as the ingenious Dr. *Keil* ſaith,) *ſuppoſing the greateſt Diſtance of the two Sides of the* Glottis, *to be one tenth Part of an Inch in ſounding twelve Notes, (to which the Voice eaſily reaches;) this Line muſt be divided into twelve Parts, each of which gives the Aperture requiſite for ſuch a Note, with a certain Strength. But if we conſider the Sub-diviſion of Notes, into which the Voice can run, the Motion of the Sides of the* Glottis *is ſtill vaſtly nicer. For if two Chords ſounding exactly Uniſons, one be ſhortened one two-thouſandth Part of its Length, a juſt Ear will perceive the Diſagreement, and a good Voice will ſound the Difference, which is one one-hundred and ninety-ſixth Part of a Note. But ſuppoſe the Voice can divide a Note into a hundred Parts, it follows that the different Apertures of the* Glottis *actually divide the tenth Part of an Inch into twelve-hundred Parts, the*

no leſs ſo is the Tongue (*d*), which miniſters to that, and many other Uſes too.

Next, the Fabrick of the (*e*) *Trachea* deſerves eſpecial Remark. Its Valve, the *Epiglottis* on the Top, to fence againſt all Annoyances; its cartilagi- nous

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Effect of each of which produces a ſenſible Alteration upon a good Ear. But becauſe each Side of the Glottis *moves juſt equally, therefore the Diviſions are juſt double; or the Sides of the* Glottis, *by their Motion, do actually divide one-tenth Part of an Inch into two-thouſand four-hundred Parts.* Keil's Anat. cap. 3. ſect. 7.

(*d*) Among the Inſtruments of Speech, the Tongue is a neceſſary one; and ſo neceſſary, that it is generally thought no Speech can be without it. But in the third Tome of the *Ephem. Germ.* is Publiſhed, *Jac. Rolandi Agloſſoſtomographia, ſive Deſcriptio Oris ſine Linguâ quod perfectè loquitur, & reliquas ſuas functiones naturaliter exercet.* The Perſon deſcribed is one *Pet. Durand*, a *French* Boy of eight or nine Years old, who at five or ſix loſt his Tongue by a *Gangrene*, occaſion'd by the Small-Pox: Notwithſtanding which, he could (as the Title ſaith) ſpeak perfectly, as alſo taſte, ſpit, ſwallow, and chew his Food; but this Latter he could do only on that Side he put it into, not being able to turn it to the other Side his Mouth.

In the ſame Tract, *Chap. 6.* is this Obſervation of *Ventriloquous* Perſons; *Memini me à quodam ſat celebri Anatomico audiviſſe, dum de duplicaturâ Mediaſtini ageret, ſi Membrana iſta duplex naturaliter unita in duas partes dividatur, loquelam quaſi ex pectore procedere, ut circumſtantes credant Dæmoniacum hunc, aut Sternomythum.*

(*e*) *The Variation of the Wind-pipe is obſervable in every Creature, according as it is neceſſary for that of the Voice. In an* Urchin, *which hath a very ſmall Voice, it is hardly more than membranous: And in a* Pidgeon, *which hath a low and ſoft Note, it is partly cartilaginous, and partly membranous. In an* Owl, *which hath a good audible Note, it is more cartilaginous; but that of a* Jay, *hath hard Bones inſtead of Cartilages; and ſo of a* Linnet: *Whereby they have both of them a louder and ſtronger Note,* &c.

The Rings of the Wind-pipe are fitted for the Modulation of the Voice. For in Dogs *and* Cats, *which in the Expreſſion of divers Paſſions uſe a great many Notes, (as Men do,) they are open and flexible, as in Man. Whereby all, or any of them are dilated, or contracted, more or leſs, as is convenient for a higher or deeper Note,* &c. *whereas in ſome other Animals, as in the* Japan-Peacock, *which uſeth hardly more than one ſingle Note, they are entire,* &c. Grew's Coſmolog. Sacr. Book I. Chap. 5. Sect. 9, 10.

(*f*) It

ous Rings (*f*) nearly environing it, with its mem-
ranous Part next the Gullet, to give the freer Paſ-
ge to the Deſcent of the Food. And laſtly, Its
nner Tegument of exquiſite Senſe to be readily
ffected with, and to make Efforts againſt every
hing that is hurtful or offenſive; theſe, I ſay, do
l juſtly deſerve our Admiration.

And no leſs prodigious are the Parts farther with-
; the *Bronchi*, the *Veſiculæ* (*g*), with their muſ-
cular

(*f*) It is a farther manifeſt Indication of ſingular Deſign in
e cartilaginous Rings of the *Aſpera Arteria*, that all the
ay where they are contiguous to the *Oeſophagus*, they are
embranous, to afford an eaſy Paſſage to the Food; but after
at, in the *Bronchi*, they are, ſome compleatly annular, ſome
angular, &c. And another obſervable is, the lower Parts
the ſuperior Cartilages, receive the upper Parts of the
erior in the *Bronchi*; whereas in the *Aſpera Arteria*, the Car-
ages run and remain Parallel to one another; which is a
ble Difference or Mechaniſm in this (in a Manner) one
d the ſame Part, enabling the Lungs, and *Bronchi*, to con-
ct themſelves in Expiration, and to extend and dilate
emſelves in Inſpiration.

(*g*) I ſhall not here intrench ſo much upon the Anatomiſt's
ovince, to give a Deſcription of the *Lungs*, although it be
curious Piece of God's Workmanſhip; but refer to Seignior
alpighi, the firſt Diſcoverer of their *Veſiculæ* in 1660, in his
o Letters to *Borelli de Pulmon.* Alſo to Dr. *Willis*'s *Pharm. rat.*
g. 2. Sect. 1. Cap. 1. *de Reſpir. Orig. & Uſ.* who as he wrote
ter *Malpighi*, ſo hath more accurately deſcribed thoſe Parts;
d to Mr. *Cowper*'s *Anat. Tab.* 24, 25. And if the Reader
th a Mind to ſee what Oppoſition Seignior *Malpighi*'s Diſ-
veries met with at Home and Abroad, and what Contro-
rſies he had on that Account; as alſo his Cenſures of Dr.
illis's Deſcription and Figures, he may conſult *Malpighi*'s
ife written by himſelf. *Pag.* 4, to 21.

That the *Lungs* conſiſt of *Veſiculæ*, or *Lobuli* of *Veſiculæ* ad-
itting of Air from the *Bronchi*, is viſible, becauſe they may
e blown up, cleanſed of Blood, and ſo dried. But Mr. *Cow-*
r ſaith, he could never part the *Lobuli*, (ſo as to make Dr.
illis's *Fig.* 1. *Tab.* 3, & 4.) ſo that probably the *Veſiculæ* are
ontiguous to one another throughout each Lobe of the Lungs.

And

cular Fibres (*h*), as ſome aſſert they have, together with the Arteries and Veins, which every where accompany the airy Paſſages, for the Blood to receive there its Impregnations from the Air.

From hence I might proceed to the commodious Form of the Ribs (*i*), the curious Mechaniſm of the

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And not only Air; but *Diemerbroeck* proves, That the *Veſiculæ* admit of Duſt alſo, from two Aſthmatick Perſons he opened; one a Stone-cutter's Man, the *Veſiculæ* of whoſe Lungs were ſo ſtuffed with Duſt, that in cutting, his Knife went as through an Heap of Sand; the other was a Feather-driver, who had theſe Bladders filled with the fine Duſt or Down of Feathers.

(*h*) There is a conſiderable Difference between Dr. *Willis* and *Etmuller*, *viz.* Whether the *Veſiculæ* of the Lungs have any muſcular Fibres, or not? *Etmuller* expreſly ſaith, *Nullas habras muſculoſas, multo minùs rubicundam Muſculorum compagem (ſunt enim Veſiculæ albidæ & fere diaphanæ) in ipſis reperiri.* Ubi ſupra, cap. 6. ſect. 2. And afterwards, ſect. 3. *Pulmones eſſe molles flexileſque muſculoſis fibris ſeu propriæ explicationis organis deſtitutos.* But Dr. *Willis* as expreſly aſſerts, they have muſculous Fibres, and aſſigns an excellent Uſe of them; *Cellulæ iſtæ veſiculares, ut nixus pro expiratione contractivos edant, etiam fibras, uti per Microſcopium planè conſpicere eſt, muſculares obtinent.* Ubi ſupra, ſect. 16. And in the next Section, *Ut pro datâ occaſione majorem aëris copiam exſufflent, aut materiam extuſſiendam ejiciant, fibris muſcularibus donatæ, ſeſe arctiùs contrahunt, contentaque ſua penitùs emolliunt. Et enim ordinariæ pectoris Syſtolæ, quas muſculorum relaxationes ex parte efficiunt, aërem forſan totum à Tracheâ & Bronchiis haud tamen à Veſiculis, quâque vice ejiciunt: propter has (quotiescunque erit) inaniendas, & totius Pectoris cavitas plurimùm anguſtatur, & cellulæ ipſæ veſiculares à propriis fibris conſtrictis coarctantur.*

(*i*) *Circa hos motus* [*Scil. Pectoris dilatationem, &c.*] *divini Conditoris mechanicen, ad regulas Mathematicas planè adaptam, ſatis admirari non poſſumus; ſiquidem nullâ aliâ in re manifeſtiùs* Θεὸν γεωμετρεῖν *videtur. Quippe cùm pectoris, tum ampliatio, tum coarctatio à quibuſdam Muſculis (quorum munus unicum eſt contrahere) proficiſci debeat; res ita inſtituitur, ut Coſtæ quæ thoracis, velut parallelogrammi oblongi verſus cylindrum incurvati, latera efformant, in figuram modò quadratam, cum angulis rectis, pro pectoris ampliatione; modò rhomboeidem, cum angulis acutis pro ejuſdem contractione, ducantur, &c.* Willis, ubi ſupra, ſect. 28. Gal

e Intercoſtal-Muſcles (*k*), the Diaphragm, and all e other Muſcles (*l*) miniſtring both to the ordi- ry, and extraordinary Offices of Reſpiration. But

Galen having ſpoken of the Parts miniſtring to Reſpiration, ncludeth, *Nihil uſquam à Naturâ ullo pacto per incuriam, fuiſſe teritum, quæ cùm omnia præſentiret & provideret, quæ ſunt neceſ- a illa, quæ cauſa alicujus extiterunt, conſecutura, omnibus inſtau- ones parare occupavit, cujus apparatus copioſa facultas admirabilem ientiam teſtantur.* De Uſ. Part. l. 5. c. 15. See alſo *l.* 6. *c.* 1.

(*k*) For the Structure of the *Intercoſtals*, *Midriff*, &c. I ſhall er to Dr. *Willis*, and other Anatomiſts. But Dr. *Drake* tax- Dr. *Willis* with an Error, in fancying there is an Oppoſi- n in the Office of the *Intercoſtals*, by Reaſon that the Fibres he *external* and *internal Intercoſtals* decuſſate; that therefore *external* ſerve to raiſe the Ribs, the *internal* to draw them wn. But Dr. *Drake* is of *Steno*'s, and Dr. *Mayow*'s Opinion. at notwithſtanding the Decuſſation of their Fibres, the wer they exert upon, and the Motion they effect in the bs, is one and the ſame. *Drake*'s *Anat. l.* 2. *c.* 7. and *l.* 4. . *Mayow de Reſpir. c.* 7.

(*l*) Although Dr. *Drake*, and ſome others, deny the *Inter- als* being Antagoniſt-Muſcles, as in the preceding Note; they, and moſt other Anatomiſts that I have met with, ribute a conſiderable Power to them in the Act of Reſpi- ion, as they do alſo to the *Subclavian* and *Triangular-Muſ-* ; but the learned *Etmuller* denies it for theſe three Rea- ns, 1. *Quia reſpirando nullam in illis contractionem ſentio.* 2. *Quia —ſibi invicem non adducuntur, &c.* 3. *Quia Coſtæ omnes ab aliis dò enarratis muſculis moventur, idque ſimul, &c. Intercoſtales ita- , necnon Subclavios Muſculos Coſtis, parietum inſtar, ad complenda erſtitia intercoſtalia, pectuſque integrandum, ac Coſtas connectendas, ertectos eſſe, probabiliter concludo; quo munere triangulares etiam —fungi, rationi conſentaneum eſt.* Etmul. Diſſert. 2. cap. 4. ct. 6.

But as to the Uſe of the *Triangular-Muſcle* in Reſpiration, e may judge of it, from its remarkable Size and Uſe in a og; of which Dr. *Willis* gives this Account from *Fallopius*: *Homine parvus adeò & ſubtilis iſte* [Muſculus] *eſt, ut vix pro uſculo accipi queat: in Cane per totum os pectoris protenditur, & rtilagines omnes, etiam verarum Coſtarum ſterno inoſculatas, occu- t: Cujus diſcriminis ratio divinam circa Animalium fabricas Provi- ntiam planè indigitat. Quippe cum hoc animal, ad curſus velociſſi- os & diu continuandos natum, quo ſanguis, dum intenſius agitatur,*

vitæ

But paſſing them by, I ſhall ſtop at one prodigious Work of Nature, and manifeſt Contrivance of the Almighty Creator, which although taken Notice of by others (*m*), yet cannot be eaſily paſſed by in the Subject I am upon; and that is the Circulation of the Blood in the *Fœtus in the Womb*, ſo different from the Method thereof after it is Born. In the Womb, whilſt it is as one Body with the Mother, and there is no Occaſion, nor Place for Reſpiration, there are two Paſſages (*n*) on Purpoſe for the Tranſmiſſion of the Blood without paſſing it through the Lungs

ritè accendatur eventileturque, aërem celerrimè & fortiter uti inſpiret, ita etiam exſpirare debet——idcirco propter hunc actum firmius deſtinandum (cujus in Homine haud magnus eſt uſus) muſculus caninus nobilis ingentem & tanto operi parem ſortitur. Willis, ubi ſupra, ſect. 32.

(*m*) Ray's *Wiſdom of God in the Creation.* Pag. 343.

(*n*) Mr. *Cheſelden*, an ingenious and moſt accurate Anatomiſt, having ſomewhat Particular in his Obſervations about the Circulation of the Blood through the Heart of the Fœtus, I ſhall preſent the Reader with ſome of his Obſervations which he favoured me with the Sight of. *The Blood* (ſaith he) *which is brought to the Heart by the aſcending* Cava, *paſſes out of the Right Auricle into the Left, through a Paſſage called* Foramen Ovale, *in the* Sceptum [common to them both] *without paſſing through the Right Ventricle (as after the Birth) while the Blood from the deſcending* Cava *paſſeth through the Right Auricle and Ventricle into the Pulmonary Artery, and thence into the* Aorta *through the Duct betwixt that and the Pulmonary Artery, called* Ductus Arteriosus, *whilſt a ſmall Portion of the Blood, thrown into the Pulmonary Artery, paſſeth through the Lungs, no more than is ſufficient to keep open the Pulmonary Veſſels. Thus both Ventricles are employed in driving the Blood through the* Aorta *to all Parts of the* Fœtus, *and to the Mother too. But after the Birth, the Blood being to be driven from the Aorta through the* Fœtus *alone, and not the Mother too, one Ventricle becomes ſufficient, whilſt the other is employed in driving the Blood through the Lungs, the* Ductus Arteriosus *being ſhut up by means of the Alteration of its Poſition, which happens to it from the raiſing the* Aorta *in the Lungs, when they become inflated. After that the Blood is thus driven into the Lungs, in its return it ſhuts the* Valve *of the* Foramen Ovale *againſt the* Foramen *it ſelf, to whoſe Sides it ſoon adheres,*

ngs. But as ſoon as the *Fœtus* is Born, and be-
me thereby a perfectly diſtinct Being, and breathes
it ſelf, then theſe two Paſſages are ſhut up; one
arly obliterated, the other becomes only a Liga-
nt, except in ſome Creatures that are Amphibi-
s, or are forced to lie long under Water, in whom
ſe Paſſages probably remain open (*o*).

And now what Action of any rational Creature,
at is there in a Man's Life, that doth more
plainly

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ps up the Paſſage. The Ductus Arterioſus, or Ductus Arte-
ſus in Ligamentum verſus, *is ſeldom to be diſcerned in adult Bo-
but the Figure of the* Foramen Ovale *is never obliterated.*

o) It hath been generally thought to be not improbable,
that on ſome Occaſions the *Foramen Ovale* may remain
n in Man. In a Girl of four or five Years of Age, Dr.
or found it but half cloſed, and in the Form of a Creſ-
t. And he thinks ſomewhat of this Kind might be in the
ſon whoſe Skeleton was found to have no Joints in the
k-Bone, Ribs, &c. Of which a Deſcription, with Cuts,
be found in *Phil. Tranſ.* No. 215. And more largely in his
ert. Med. Phyſ. de ſtupendo Oſſicum coalitu, where he adds to
Girl, in whom the *For. Ov.* was not ſhut, a like Obſer-
ion of another Girl he opened at *Oxford* of three Years
; *In quâ Foramen Ovale ferè erat occluſum, in medio tamen, exili
mine, per quod Turundam facilè tranſmiſi, erat pervium*, p. 30.
Mr. *Cowper* (than whom none more accurate and a better
ge) ſaith, *I have often found the* Foramen Ovale *open in the
lt.* Anat. Append. Fig. 3. But Mr. *Cheſelden* is of a diffe-
t Opinion. Of which in the following Note.

From ſomewhat of this Cauſe, I am apt to think it was
t the *Tronningholm* Gardiner eſcaped drowning, and ſome
ers mentioned by *Pechlin*. His Stories are, *Hortulanus Tron-
gholmenſis etiamnum vivens, annos natus* 65, *pro illâ ætate ſatis
uc valens & vegetus, cùm ante* 18 *annos, alii in aquas delapſo opem
re vellet, ſorte fortunâ & ipſe per glaciem incautiùs procedens, aquas
idit* 18 *ulnas profundas: ubi ille, corpore erecto quaſi ad perpendiculum,
libus fundo adhæſit. Conſtitit ſic per* 16 *horas, antequàm producere-
in auras. Dixit autem, ſimul ac infra aquarum ſuperficiem fuit
merſus, ſtatim obriguiſſe totum, &, ſi quem tum habuit motum &
ſum, amiſiſſe, niſi quod ſonantes Stockolmii campanas etiam ſub
uis obſcuriùs percipere ſibi ſit viſus. Senſit etiam, ſtatim ſeſe velut
veſiculam*

plainly ſhew Deſign, Reaſon, and Contrivanc
than this very Act of Nature doth the Contrivan
an

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*veſiculam ori appliçâſſe, adeò ut aqua nulla os penetraverit, in ar
verò tranſitum, etiam ſentiente illo, habuerit; atque inde auditum ſu
debilitatum aliquandiu eſſe. Hoc ſtatu dum 16 horas permanſit ſp
ſtrà quæſitus, tandem repertum, conto in caput infixo, cujus etiam ſp
ſum ſe habuiſſe dixit, fundo extraxerunt, ſperantes ex more aut perſu
ſione gentis revicturum eſſe. Itaque pannis linteiſque productum obv
vunt, ne aëre admitti poſſit perniciôſus futurus ſubito illapſu: cuſtod
tum ſic ſatis ab aëre ſenſim ſenſimque tepidiori loco admovent mox calid
adoriuntur faſciis, fricant, radant, & ſufflaminatum tot horis ſanguin
corporiſque motum negotiosâ illâ operâ reducunt: denique antapoplect
& genialibus liquoribus vitæ reddunt & priſtinæ mobilitati. Retuli
atque oſtendit ſe etiamnum in capite circumferre veſtigia violentiæ
conto illatæ, & cephalalgiis vexari graviſſimis. Et propter hunc ipſ
caſum religiosè à popularibus, & hujuſce rei teſtibus probatum, Sere
ſimæ Reginæ matris munificentia & annuo ſtipendio eſt donatus—
Sereniſ. Principi ——oblatus vivus ſui teſtis ——Conſignatam m
habes Hiſtoriam D. Tilaſii, Biblioth. Reg. Præfecti, qui teſtatus e
prænoviſſe mulierem, quæ tres ipſos dies ſub aquis hæſit, & ſimil
modum, quo Hortulanus ille, reſuſcitata, adhuc dum lucis plenâ fru
uſurâ. Accedit Nob. Burmanni——fides, qui confeſſus eſt, —
pago* Boneſs *parochiæ* Pithoviæ *concionem frequentâſſe funebrem,
quâ, dum acta recenſeret Præco Senis cujuſdam ſeptuagenarii La
*Jonæ——audiverit ex ore Concionatoris, vivum eum, adoleſcentem
annorum, aquis ſubmerſum, 7 demum hebdomadâ (rem prodigioſam
extractum ad ſe rediiſſe vivum & incolumen.* Pechlin. de Aer.
Alim. def. c. 10.

Shall we to this Cauſe, or to the Oſſification, or more tha
ordinary Strength of the Wind-Pipe, attribute the Recove
to Life of Perſons hanged? Of which *Pechlin* gives an
ſtance that fell under his own Knowledge, of a Woman han
ed, and in all Appearance dead, but recovered by a Phyſici
accidentally coming in, with a plentiful Adminiſtration
Spir. Sal. Armon. Pechl. ib. c. 7. And the Story of *Anne Gre*
executed at *Oxford*, *Dec.* 14, 1650. is ſtill well remembere
among the Seniors there. *She was hanged by the Neck near h
an Hour, ſome of her Friends in the mean Time thumping her on t
Breaſt, others hanging with all their Weight upon her Legs, ſometim
lifting her up, and then pulling her down again with a ſudden Jer
thereby the ſooner to diſpatch her out of her Pain*; as her printe
Account wordeth it. After ſhe was in her Coffin, being ob
ſerved to breathe, a luſty Fellow ſtamped with all his For

d Deſign of the great GOD of Nature? What is hought and Contrivance, if this be not? Namely, hat there ſhould be a temporary Part in the Body, ade juſt for the preſent Exigence; to continue hilſt there is Occaſion for it, and to ceaſe when ere is none; in ſome Creatures to remain always, Reaſon of their amphibious Way of Living, and Land-Animals (purely ſuch) to ceaſe.

Another excellent Contrivance, a-kin to the laſt, for the Preſervation of ſuch Creatures whoſe Oc-ions frequently neceſſitate them to live without, with but little Reſpiration: Fiſhes might be med here, whoſe Habitation is always in the aters; but theſe belong to an Element which I not at preſent engage in. But there are many imals of our own Element, or partly ſo, whoſe gans of Reſpiration, whoſe Blood, whoſe Heart, d other Inſtruments of Life, are admirably ac-mmodated to their Method of Living: Thus ma-amphibious Creatures (*p*), who live in Water as

her Breaſt and Stomach, to put her out of her Pain. t by the Aſſiſtance of Dr. *Peity*, Dr. *Willis*, Dr. *Bathurſt*, d Dr. *Clark*, ſhe was again brought to Life. I my ſelf ſaw r many Years after, after that ſhe had (I heard) born di-rs Children. The Particulars of her Crime, Execution d Reſtauration, ſee in a little Pamphlet, called *News from Dead*, written, as I have been informed, by Dr. *Bathurſt*, terwards the moſt vigilant and learned Preſident of *Tri-y-College*, *Oxon*,) and publiſhed in 1651, with Verſes upon e Occaſion.

(*p*) The *Sea-Calf* hath the *Foramen Ovale*, by which Means it enabled to ſtay long under the Water, as the *Pariſ. Ana-niſts*. Of which ſee in *Book* VI. *Chap.* 5. *Note* (*c*).

But the fore-commended Mr. *Cheſelden*, thinks the *Foramen vale* is neither open in amphibious Creatures, nor any adult and-Animals. *When I firſt* (ſaith he) *applied my ſelf to the Diſ-ſion of Human Bodies, I had no diſtruſt of the frequent Accounts of*

the

as well as Air; many Quadrupeds, Birds, Inſects and other Animals, who can live ſome Hours, Days yea, whole Winters, with little or no Reſpiration in a Torpitude, or ſort of Sleep, or middle State between Life and Death: The Proviſion made for theſe peculiar Occaſions of Life, in the Fabrick of the Lungs, the Heart, and other Parts of ſuch Creatures (*q*), is manifeſtly the Work of Him, who as St. *Paul* ſaith (*r*), *Giveth to all Breath, and Life, and all Things.*

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the Foramen Ovale *being open in Adults; but I find ſince, that miſtook the* Oſtium Venarum Coronariarum *for the* Foramen. *The like I ſuppoſe Authors have done, who aſſert that it is always open in amphibious Animals; for we have made diligent Enquiry into theſe Animals, and never found it open. Neither would that (as they imagine) ſerve theſe Creatures to live under Water, as the* Fœtus *doth in* Utero, *unleſs the* Ductus Arterioſus *was open alſo.*

This Opinion of Mr. *Cheſelden* hath this to render it probable, That the *Oſtium Venarum Coronariarum* is ſo near the *Foramen Ovale*, that without due Regard, it may be eaſily miſtaken for it. Such therefore as have Opportunity of examining this Part in amphibious Animals, or any other Subject, ought to ſeek for the *Oſtium*, whenever they ſuſpect they have met with the *Foramen*.

(*q*) Of the ſingular Conformation of the Heart and Lungs of the *Tortoiſe*, which is an Amphibious Animal. See Book VI. *Chap.* 5. *Note* (*b*).

(*r*) *Acts* xvii. 25.

CHAP. VIII. *Of the Motion of Animals.*

NEXT to the two Grand Acts of Animal Life their Senſe or Reſpiration, I ſhall conſider their *Motion*, or *Locomotive Faculty*; whereby they convey themſelves from Place to Place, according to their Occaſions, and Way of Life: And the admirable Apparatus to this Purpoſe, is a plain Demon-

)emonſtration of God's particular Foreſight, Care, nd eſpecial Providence towards all the Animal Vorld.

And here I might View, in the firſt Place, the uſcles, their curious Structure (*a*), the nice tack- g them to every Joint, to pull it this Way, and at Way, and the other Way, according to the ecial Purpoſe, Deſign, and Office of every ſuch int: Alſo their various Size and Strength; ſome rge and corpulent, others leſs, and ſome ſcarce ible to the naked Eye; all exactly fitted to every ace, and every Uſe of the Body. And laſtly, I ight take Notice of the muſcular Motions, both voluntary and ſpontaneous (*b*).

Next,

(*a*) That the Muſcles are compounded of Fibres, is viſible ough. Which Fibres, the curious and ingenious *Borelli* h, are cylindraceous; not hollow, but filled with a ſpungy, hy Subſtance, after the Manner of Elder, as he diſcovered his Microſcopes. *Borel. de Mot. Animal. Part* 1.

Theſe Fibres, he ſaith, are naturally white; but derive ir Redneſs only from the Blood in them.

Theſe Fibres do in every Muſcle, (in the Belly at leaſt of Muſcle,) run Parallel to one another, in a neat orderly rm. But they do not at all tend the ſame Way, but ſome aſſant, ſome long-ways, &c. according to the Action or ſition of each reſpective Muſcle. The Particulars of which, d of divers other Obſervables in the Muſcles, would, beſides gures, take up too much Room in theſe Notes; and there- e I muſt refer to the Anatomiſts, particularly *Steno*, *Borelli*, *wper*, &c.

(*b*) The Infinite Creator hath generally exerted his Art d Care, in the Proviſion made by proper Muſcles and erves, for all the different Motions in Animal Bodies, both voluntary, and voluntary. It is a noble Providence, that oſt of the vital Motions, ſuch as of the Heart, Stomach, uts, &c. are involuntary, the Muſcles acting whether we ep or wake, whether we will, or no. And it is no leſs ovidential that ſome, even of the vital Motions, are partly luntary, partly involuntary, as that for Inſtance, of Breath-

Next, I might Survey the ſpecial Fabrick of the Bones (*c*), miniſtring to Animal Motion. Next, I might

ing, which is performed both ſleeping and waking; but can be intermitted for a ſhort Time on Occaſion, as for accurate Hearing any Thing, &c. or can be encreaſed by a ſtronger Blaſt, to make the greater Diſcharges of the Blood from the Lungs, when that any Thing overcharges them. And as for the other Motions of the Body, as of the Limbs, and ſuch as are voluntary, it is a no leſs Providence, that they are abſolutely under the Power of the Will; ſo as that the Animal hath it in his Power to command the Muſcles and Spirits, or any Part of its Body, to perform ſuch Motions and Actions as it hath Occaſion for.

(*c*) *Quid dicam de Oſſibus? qua ſubjecta corpori mirabiles commiſſuras habent, & ad ſtabilitatem aptas, & ad artus finiendos accommodatas, & ad motum, & ad omnem corporis actionem.* Cicer. de Nat. Deor. l. 2. c. 55.

By Reaſon it would be endleſs to mention all the Curioſities obſervable in the Bones, I ſhall for a Sample, ſingle out only an Inſtance or two, to manifeſt that Deſign was uſed in the Structure of theſe Parts in Man.

The firſt ſhall be in the *Back-Bone*, which (among many others) hath theſe two Things remarkable. 1. Its different Articulations from the other Joints of the Body. For here moſt of the Joints are flat, and withal guarded with Aſperities and Hollows, made for catching and holding; ſo as firmly to lock and keep the Joints from Luxations, but withal to afford them ſuch a Motion, as is neceſſary for the Incurvations of the Body. 2. The difference of its own Joints in the Neck, Back and Loins. In the Neck, the *Atlas*, or upper *Vertebra*, as alſo the *Dentata*, are curiouſly made, and jointed (differently from the reſt) for the commodious and eaſy bending and turning the Head every Way. In the *Thorax*, or Back, the Joints are more cloſe and firm; and in the Loins more lax and pliant; as alſo the Spines are different, and the Knobs and Sockets turned the quite contrary Way, to anſwer the Occaſions the Body hath to bend more there, than higher in the Back. I ſhall cloſe this Remark with the ingenious Dr. *Keil*'s Obſervation.

The Structure of the Spine *is the very beſt that can be contrived; for had it been all Bone, we could have had no Motion in our Backs; had it been of two or three Bones articulated for Motion, the* Medulla Spinalis *muſt have been neceſſarily bruiſed at every Angle or Joint; beſides,*

eſides, the whole would not have been ſo pliable for the ſeveral Poſtures we have Occaſion to put our ſelves in. If it had been made of ſeveral Bones without intervening Cartilages, we ſhould have had no more Uſe of , than if it had been but one Bone. If each Vertebra *had had its own iſtinct Cartilages, it might have been eaſily* diſlocated. *And laſtly, The oblique Proceſſes of each ſuperior and inferior* Vertebra, *keep the iddle one that it can neither be thruſt backwards nor forwards to com-reſs the* Medulla Spinalis. Keil's Anat. cap. 5. ſect. 8.

Compare here what *Galen* ſaith of the Articulations, Liga-ents, Perforation, &c. of the *Spine*, to prove the Wiſdom nd Providence of the Maker of Animal Bodies, againſt ſuch found Fault with Nature's Works; among which he names iagoras, *Anaxagoras*, *Aſclepiades* and *Epicurus*. *Vid. Galen. de Uſ. art. l.* 12. *init.* and *Chap.* 11, &c. alſo *L.* 13. *init.*

2. The next Inſtance ſhall be in one or two Things, where-the Skeletons of Sexes differ. Thus the *Pelvis* made in e Belly by the *Ilium*, *Oſſa Coxendicis* and *Pubis*, is larger in a male than Male Skeleton, that there may be more Room r the lying of the *Viſcera* and *Fœtus*. So the Cartilage bra-ng together the two *Oſſa Pubis*, or *Sharebones*, *Bartholine* ſaith, twice thicker and laxer in Women than Men: As alſo is e Cartilage that tieth the *Os Sacrum* to its *Vertebra*; and all give Way to the Paſſage of the *Fœtus*.

Another conſiderable Difference is in the cartilaginous oduction of the ſeven long Ribs, whereby they are braced the Breaſt-Bone. Theſe are harder and firmer in Wo-en than in Men; the better to ſupport the Weight of the reaſts, the ſucking Infant, &c.

(*d*) It is remarkable in the Joints, and a manifeſt Act of ution and Deſign: 1. That altho' the Motion of the Limbs circular, yet the Center of that Motion is not in a Point, t an ample Superficies. In a Point, the Bones would wear d penetrate one another; the Joints would be exceedingly ak, &c. but the Joints conſiſting of two large Superficies, oncave, and Convex, ſome furrowed and ridged, ſome like Ball and Socket, and all lubricated with an oily Subſtance, ey are incomparably prepared both for Motion and Strength.

That the Bones next the Joint are not ſpungy, as their Ex-emities commonly are, nor hard and brittle, but capped ith a ſtrong, tough, ſmooth, cartilaginous Subſtance, ſerving oth to Strength and Motion.

But let us here take Notice of what *Galen* mentions on this ubject. *Articulorum unuſquiſque Eminentiam Cavitati immiſſam abet: Verumtamen hoc fortaſſe non adeò mirabile eſt: Sed ſi, conſide-tâ omnium totius corporis oſſium mutuâ connexione, Eminentias ca-itatibus ſuſcipientibus æquales ſemper inveneris; Hoc mirabile. Sit*

might take Notice of the Joints (*d*), their compleat Form adjusted to the Place, and Office they are employed in; their Bandage, keeping them from Luxations; the oily Matter (*e*) to lubricate them, and their own Smoothness to facilitate their Motion.

And lastly, I might trace the various Nerves throughout the Body, sent about to minister to its various Motions (*f*). I might consider their Origin (*g*)

enim justo amplior esset Cavitas, laxus sanè & infirmus fieret Articulus; si strictior, motus difficulter fieret, ut qui nullam versionem haberet; ac periculum esset non parvum, eminentias ossium arctatas frangi; sed horum neutrum factum est. ——Sed quoniam ex tam securâ constructione periculum erat, nè motiones difficilius fierent, & eminentiæ ossium extererentur, duplex rursus auxilium in id Natura molita est. 1. Cartilagine os utrumque subungens, atque oblinens: alterum, ipsis Cartilaginibus humorem unctuosum, velut oleum, superfundens; per quem facilè mobilis, & attritu contumax omnis articulatio Ossium facta est. ——Ut undique diligenter Articulus omnis custodiretur, Ligamenta quædam ex utroque osse produxit Natura. Galen de Us. Part. l. 1. c. 15.

(*e*) For the affording this oily or mucilaginous Matter there are *Glandules* very commodiously placed near the Joints so as not to suffer too great Compression by the Motion of the neighbouring Bones, and yet to receive a due Pressure, so as to cause a sufficient Emission of the Mucilage into the Joints. Also, another Thing considerable is, that the excretory Ducts of the *Mucilaginous Glands* have some Length in their Passage from the Glands to their Mouths; which is a good Contrivance, to prevent their Mouths being oppressed by the Mucilage, as also to hinder the too plentiful Effusion thereof, but yet to afford a due Expressure of it at all Times, and on all Occasions, as particularly in violent and long-continued Motions of the Joints, when there is a greater than ordinary Expence of it. See *Cowper's Anat. Tab.* 79.

(*f*) There is no Doubt to be made, but that the Muscles receive their Motion from the Nerves. For if a Nerve be cut or streightly bound, that goes to any Muscle, that Muscle shall immediately lose its Motion. Which is doubtless the Case of Paralyticks; whose Nerves are some of them by Obstructions, or such like Means, reduced to the same State as if cut or bound.

in (*g*), their Ramifications to the ſeveral Parts, nd their Inoſculations with one another, according o the Harmony and Accord of one Part with ano- her, neceſſary for the Benefit of the Animal. But ome of thoſe Things I have given ſome Touches pon already, and more I ſhall mention hereafter (*h*), and it would be tedious here to inſiſt upon hem all.

I ſhall therefore only ſpeak diſtinctly to the Loco- notive Act it ſelf, or what directly relates to it.

And here it is admirable to conſider the various Methods of Nature (*i*), ſuited to the Occaſions of various

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And this alſo is the Cauſe of that *Numneſs* or *Sleepineſs* we nd oftentimes, by long ſitting or lying on any Part.

Neither is this a modern Notion only; for *Galen* ſaith, *Prin- ipium Nervorum omnium Cerebrum eſt, & ſpinalis Medulla.* ——*Et ervi à Cerebro animalem virtutem accipiunt* ——*Nervorum utilitas facultatem Senſûs & Motûs à principio in partes didûcere.* And his he intimates to have been the Opinion of *Hippocrates* and *Plato*, de Uſ. Part. l. 1. c. 16. & paſſim.

(*g*) Dr. *Willis* thinks, That in the *Brain* the Spirits are ela- orated that miniſter to voluntary Motion; but in the *Cere- ellum*, ſuch as effect involuntary, or natural Motions; ſuch s that of the Heart, the Lungs, &c. *Cerebri Anat. c.* 15.

(*h*) See *Book* V. *Chap.* 8.

(*i*) To the foregoing, I ſhall briefly add ſome Examples of he ſpecial Proviſion made for the Motion of ſome Animals by *Temporary Parts*. *Frogs* and *Toads*, in their *Tadpole-ſtate*, have Tails, which fall off when their Legs are grown out. The *Lacerta Aquatica*, or *Water-Newt*, when Young, hath four neat amified Fins, two on a Side, growing out a little above its Fore-legs, to poiſe and keep its Body upright, (which gives it he Reſemblance of a young Fiſh,) which fall off when the Legs are grown. And the *Nymphæ* and *Aureliæ*, of all or moſt of the Inſects bred in the Waters, as they have particular Forms, different from the Inſects they produce; ſo have alſo peculiar Parts afforded them for their Motion in the Waters: Oars, Tails, and every Part adapted to the Waters, which are utterly varied in the Inſects themſelves, in their *mature State* in the Air.

various Animals. In ſome their Motion is ſwift, in others ſlow. In ſome performed with two, four, or more Legs; in ſome with two, or four Wings; in ſome with neither (*k*).

And firſt for ſwift or ſlow Motions. This we find is proportional to the Occaſions of each reſpective Animal. *Reptiles*, whoſe Food, Habitation, and Neſts, lie in the next Clod, Plant, Tree, or Hole, or can bear long Hunger and Hardſhip, they need neither Legs nor Wings for their Tranſportation; but their vermicular or ſinuous Motion (performed with no leſs Art, and as curiouſly provided for as the Legs or Wings of other Creatures: This, I ſay,) is ſufficient for their Conveyance.

Man and *Beaſts*, whoſe Occaſions require a large Room, have accordingly a ſwifter Motion, with proper Engines for that Service; anſwerable to their Range for Food, their Occupation of Buſineſs, or their want of Armature, and to ſecure them againſt Harms (*l*). But

(*k*) *Jam verò alia animalia gradiendo, alia ſerpendo, ad paſtum accedunt, alia volando, alia nando.* Cic. de Nat. Deor. l. 2. c. 47.

Compare alſo what *Galen* excellently obſerves concerning the Number of Feet in Man, and in other Animals; and the wiſe Proviſion thereby made for the Uſe and Benefit of the reſpective Animals. *De Uſ. Part.* in the Beginning of the third Book.

(*l*) As I ſhall hereafter ſhew, That the Indulgent Creator hath abundantly provided for the Safety of Animals by their Cloathing, Habitations, Sagacity and Inſtruments of Defence; ſo there appears to be a Contemperament of their *Motion* with theſe Proviſions. They that are well armed and guarded, have commonly a ſlower Motion; whereas they that are deſtitute thereof, are ſwifter. So alſo timid helpleſs Animals are commonly ſwift; thus Deer and Hares: But Animals endowed with Courage, Craft, Arms, &c. commonly have a ſlower Motion.

(*m*) See

But for the winged Creatures (Birds and Inſects,) as they are to traverſe large Tracts of Land and Water, for their Food, for their commodious Habitation, or Breeding their Young, to find Places of Retreat and Security from Miſchiefs; ſo they have accordingly the Faculty of flying in the Air; and that ſwiftly or ſlowly, a long or ſhort a Time, according to their Occaſions and Way of Life. And accordingly their Wings, and whole Body, are curiouſly prepared for ſuch a Motion; as I intend to ſhew in a proper Place (*m*).

Another remarkable Thing in the motive Faculty of all Creatures, is the neat, geometrical Performance of it. The moſt accurate Mathematician, the moſt skilful in mechanick Motions, cannot prescribe a nicer Motion (than what they perform) to the Legs and Wings of thoſe that walk or fly (*n*), or to the Bodies of thoſe that creep (*o*). Neither can the Body be more compleatly poiſed for the Motion it is to have in every Creature, than it already actually is. From the largeſt Elephant to the ſmalleſt Mite, we find the Body artfully balanced (*p*). The Head not too heavy, nor too light for the reſt of the Body, nor the reſt of the Body for it (*q*). The

(*m*) See *Book* VII. *Chap.* 1.

(*n*) See *Book* VII. *Chap.* 1. the End.

(*o*) See *Book* IX. *Chap.* 1. *Note* (*c*).

(*p*) *Siquis unquam alius Opifex, æqualitatis & proportionis magnam habuit providentiam, certè Natura habuit in animalium corporibus conformandis; unde Hippocrates eam rectiſſimè juſtam nominat.* Galen. de Uſ. Part. l. 2. c. 16.

(*q*) The Make of the Bodies of ſome Water-Fowl, ſeems to contradict what I here ſay, the Heads and long Necks of ſome, as of Swans, Ducks and Geeſe; and the hinder Parts of others, as of the Doucker and Moor-hen, and ſome other

The *Viſcera* are not let looſe, or ſo placed, as to ſway over-balance, or over-ſet the Body; but well-braced and diſtributed to maintain the æquipoiſe of the Body. The motive Parts alſo are admirably well fixed in reſpect to the Center of Gravity; placed in the very Point, fitteſt to ſupport and convey the Body. Every Leg beareth his true Share of the Body's Weight. And the Wings ſo nicely are ſet to the Center of Gravity, as even in that fluid *Medium*, the Air, the Body is as truly balanced, as we could have balanced it with the niceſt Scales.

But among all Creatures, none more elegant than the ſizing the Body of *Man*, the gauging his Body ſo nicely, as to be able to ſtand erect, to ſtoop, to ſit, and indeed to move any way, only with the Help of ſo ſmall a Stay as the Feet (*r*): whoſe Mechaniſm of Bones, Tendons and Muſcles to this Purpoſe, is very curious and admirable.

Kinds, ſeeming to be too heavy for the reſt of their Body. But inſtead of being an Argument againſt, it is a notable Inſtance of the Divine Art and Providence, theſe Things being nice Accommodations to their way of Life. Of ſuch as have long Necks, ſee *Book* VII. *Chap.* 2. *Note* (*i*).

And as for ſuch whoſe hinder Parts ſeem to over-balance their foremoſt Parts, whereby they fly with their Bodies in a manner erect, this alſo is an excellent Accommodation to their way of Life, which is Diving rather than Flying. *Vid. Book* VII. *Chap.* 4. *Note* (*k*).

(*r*) See *Book* V. *Chap.* 2. *Note* (*h*).

CHAP.

CHAP. IX.

the Place allotted to the ſeveral Tribes of ANIMALS.

HAving diſpatched the Motion of Animals, let us in the next Place conſider the *Place* which Infinitely Wiſe Creator hath appointed them to ove and act, and perform the Offices of the Crea- n in. And here we find every Particular well dered. All Parts of our Terraqueous Globe fit an Animal to live and act in, are ſufficiently cked with proper Inhabitants: The watery Ele- nt (unfit, one would think, for Reſpiration and e) abounding with Creatures fitted for it; its wels abundantly ſtored, and its Surface well be- ead. The Earth alſo is plentifully ſtocked in all Parts, where Animals can be of any Uſe; not obably the deepeſt Bowels thereof indeed, being rts in all likelihood unfit for Habitation and Ac- n, and where a living Creature would be uſeleſs the World; but the Surface every where abun- ntly ſtored.

But that which is moſt conſiderable in this Mat- r, and plainly ſheweth the Divine Management in e Caſe, is, that thoſe Creatures are manifeſtly ſigned for the Place in which they are, and the ſe and Services they perform therein. If all the nimals of our Globe had been made by Chance, placed by Chance, or without the Divine Provi- nce, their Organs would have been otherwiſe an they are, and their Place and Reſidence con-

fuſed

fuſed and jumbled. Their Organs [for Inſtanc
of Reſpiration, of Viſion, and of Motion, wo
have fitted any *Medium*, or have needed non
their Stomachs would have ſerved any Food, a
their Blood, and Covering of their Bodies b
made for any Clime, or only one Clime. Con
quently all the Animal World would have been i
confuſed, inconvenient, and diſorderly Commixtu
One Animal would have wanted Food, another H
bitation, and moſt of them Safety. They wo
have all flocked to one, or a few Places, taken
their Reſt in the Temperate Zones only, and cove
ed one Food, the eaſieſt to be come at, and m
ſpecious in ſhew; and ſo would have poiſoned, ſtr
ved, or greatly incommoded one another. But as t
Matter is now ordered, the Globe is equally beſpre
ſo that no Place wanteth proper Inhabitants, n
any Creature is deſtitute of a proper Place, and
Things neceſſary to its Life, Health, and Pleaſu
As the Surface of the Terraqueous Globe is c
vered with different Soils, with Hills and Val
with Seas, Rivers, Lakes and Ponds, with dive
Trees and Plants, in the ſeveral Places; ſo all th
have their Animal Inhabitants, whoſe Organs
Life and Action are manifeſtly adapted to ſuch a
ſuch Places and Things; whoſe Food and Phy
ſick, and every other Convenience of Life, is
be met with in that very Place appointed it. T
watery, the amphibious (*a*), the airy Inhabitan
a

(*a*) *Eſt etiam admiratio nonnulla in beſtiis aquatilibus iis, qua
nuntur in terrâ: veluti Crocodili, fluviatileſque Teſtudines, quedam
Serpentes orta extra aquam, ſimul ac primùm niti poſſunt, aquam
ſequuntur. Quin etiam Anatum ova Gallinis ſæpe ſupponimus*
[Pu

d thoſe on the dry Land Surface, and the Sub-raneous under it, they all live and act with Plea-e, they are gay, and flouriſh in their proper Ele-nt and allotted Place, they want neither for Food, oathing, or Retreat; which would dwindle and , deſtroy, or poiſon one another, if all coveted ſame Element, Place, or Food.

Nay, and as the Matter is admirably well order-yet conſidering the World's Increaſe, there would be ſufficient Room, Food, and other Neceſſaries all the living Creatures, without another grand of the Divine Wiſdom and Providence, which is *Balancing the Number of Individuals* of each cies of Creatures, in that Place appointed reto: Of which in the next Chapter.

lli] *deinde eas* [matres] *relinquunt——& effugiunt, cùm pri-aquam, quaſi naturalem domum, videre potuerunt* Cic. de Nat. or. l. 2. c. 48.

CHAP. X.

the Balance of Animals, or the due Proportion in which the World is ſtocked with them.

THE whole Surface of our Globe can afford Room and Support only to ſuch a Number of Sorts of Creatures. And if by their doubling, bling, or any other Multiplication of their Kind, y ſhould encreaſe to double or treble that Num-, they muſt ſtarve, or devour one another. The eping therefore the Balance even, is manifeſtly a ork of the Divine Wiſdom and Providence. o which End, the great Author of Life hath de-

termined

termined the Life of all Creatures to ſuch a Length and their Increaſe to ſuch a Number, proportion to their Uſe in the World. The Life of ſom Creatures is long, and their Increaſe but ſmall, a by that Means they do not over-ſtock the Wor And the ſame Benefit is effected, where the Increa is great, by the Brevity of ſuch Creatures Lives, their great Uſe, and the frequent Occaſions the are of them for Food to Man, or other Anima It is a very remarkable Act of the Divine Prov dence, that uſeful Creatures are produced in gre Plenty (*a*), and others in leſs. The prodigious a frequent Increaſe of Inſects, both in and out the Waters, may exemplify the one; and 'tis ob ſervable in the other, that Creatures leſs uſeful, by their Voracity pernicious, have commonly few Young, or do ſeldomer bring forth: Of whic many Inſtances might be given in the voracio Beaſts and Birds. But there is one ſo peculiar an A nimal, as if made for a particular Inſtance in o preſent Caſe, and that is the *Cuntur* of *Peru* (*b*): Fowl of that Magnitude, Strength and Appetite, to ſeize not only on the Sheep, and leſſer Cattle, b

ev

(*a*) *Benigna circa hoc Natura, innocua & eſculenta animalia fe cunda generavit.* Plin. Nat. Hiſt. l. 8. c. 55.

(*b*) *Captain* J. Strong, *gave me this Account, together with a Qu Feather of the* Cuntur [*or* Condor] *of* Peru. *On the Coaſt of Chi they met with this Bird in about* 33° *S. Lat. not far from* Mocha, *Iſland in the South-Sea, ——they ſhot it ſitting on a Cliff, by the Se ſide; that it was* 16 *Feet from Wing to Wing extended; that* Spaniſh *Inhabitants told them they were afraid of theſe Birds, they ſhould prey upon their Children. And the Feather he gave me* (ſai the Doctor) *is* 2 *Feet* 4 *Inches long; the Quill-part* 5 *Inches t quarters long, and* 1 *Inch and half about in the largeſt Part. weighed* 3 *dr.* 17 *gr. and half, and is of a dark-brown Colour.* D *Sloane* in Philoſ. Tranſ. No. 208.

en the larger Beaſts, yea, the very Children too. ow theſe, as they are the moſt pernicious of Birds, are they the moſt rare, being ſeldom ſeen, or ly one, or a few in large Countries; enough to ep up the Species; but not to over-charge the orld.

Thus the Balance of the Animal World, is, oughout all Ages, kept even; and by a curious rmony, and juſt Proportion between the Increaſe all Animals, and the Length of their Lives, the orld is through all Ages well, but not over-red: *One Generation paſſeth away, and ano-r Generation cometh (c)*; ſo equally in its om, to Balance the Stock of the Terraqueous obe in all Ages, and Places, and among all Crea-es; that it is an actual Demonſtration of our Sa-ur's Aſſertion, *Mat.* x. 29. that the moſt incon-ſiderable,

To this Account, the Doctor, (in a Letter to Mr. *Ray*, rch 31, 1694, with other Papers of Mr. *Rays*, in my Hands,) ls the Teſtimony of *Joſ. Acoſta*, *l.* 4. *c.* 7. and *Garcilaſſ. de Vaga*, who *l.* 8. *c.* 19. ſaith, *There are other Fowls, call'd* Cuntur, *by the* Spaniards *corruptly* Condor. *Many of theſe Fowls have been kill'd by the* Spaniards, *had their Proportion taken, and from d to End of their Wings meaſured* 15 *or* 16 *Feet.* ——*Nature, to per and allay their Fierceneſs, deny'd them the Talons which are en to the* Eagle; *their Feet being tipp'd with Claws like a Hen: wever, their Beak is ſtrong enough to tear off the Hide, and rip up Bowels of an* Ox. *Two of them will attempt a* Cow *or* Bull, *devour him: And it hath often happened, that one of them alone h aſſaulted Boys of ten or twelve Years of Age, and eaten them. Their our is black and white, like a* Magpie. *It is well there are but of them; for if they were many, they would very much deſtroy the ttle. They have on the Fore-part of their Heads, a Comb, not pointed e that of a* Cock; *but rather even, in the Form of a Razor. When y come to alight from the Air, they make ſuch a humming Noiſe, th the fluttering of their Wings, as is enough to aſtoniſh, or make a an deaf.*

(*c*) *Eccleſ.* i. 4.

(*d*) The

ſiderable, common Creature, *Even a Sparro*
(two of which are ſold for a Farthing) doth n
fall on the Ground without our heavenly Fathe

This Providence of God is remarkable in eve
Species of living Creatures: But that eſpecial M
nagement of the Recruits and Decays of Mankin
ſo equally all the World over, deſerves our eſp
cial Obſervation. In the Beginning of the Wor
and ſo after *Noah*'s Flood, the Longævity of Me
as it was of abſolute Neceſſity to the more ſpeed
Peopling of the new World; ſo is a ſpecial in
ſtance of the Divine Providence in this Matter (*d*)
And the ſame Providence appears in the followi
Ages, when the World was pretty well people
in reducing the common Age of Man then to 1
Year

(*d*) The Divine Providence doth not only appear in th
Longævity of Man, immediately after the Creation an
Flood; but alſo in their different Longævity at thoſe tw
Times. Immediately after the Creation, when the World wa
to be peopled by one Man, and one Woman, the Age of th
greateſt Part of thoſe on Record, was 900 Years, and up
wards. But after the Flood, when there were three Perſon
by whom the World was to be peopled, none of thoſe Patri-
archs, except *Shem*, arriv'd to the Age of 500; and only th
three firſt of *Shem*'s Line, *viz. Arphaxad*, *Salah*, and *Eber*, can
near that Age; which was in the firſt Century after the Flood
But in the ſecond Century, we do not find any reached to
Age of 240. And in the third Century, (about the latter
End of which *Abraham* was born, (none, except *Terah*, a
riv'd to 200 Years: By which Time the World was ſo wel
peopled, (that Part of it, at leaſt where *Abraham* dwelt,) tha
they had built Cities, and began to be cantoned into diſtinct
Nations and Societies, under their reſpective Kings; ſo tha
they were able to wage War, four Kings againſt five, *Gen.* xiv
Nay, if the Accounts of *Anian*, *Berothus*, *Manetho*, and other
yea, *Africanus*, be to be credited; the World was ſo wel
peopled, even before the Times we ſpeak of, as to afford ſuf
ficient Numbers for the great Kingdoms of *Aſſyria*, *Egypt*
Perſia, &c. But learned Men generally, with great Reaſon
reject theſe as legendary Accounts.

ars, (*Gen.* vi. 3.) in Proportion to the Occaſions the World at that Time. And laſtly, when the orld was fully peopled after the Flood, (as it s in the Age of *Moſes*, and ſo down to our pre- Time) the leſſening the common Age of Man o or 80 Years (*e*), (the Age mentioned by *Mo- Pſal.* xc. 10. this, I ſay,) is manifeſtly an Ap- ntment of the ſame Infinite Lord that ruleth the orld: For, by this Means, the peopled World ept at a convenient Stay; neither too full, nor empty. For if Men (the Generality of them, ean) were to live now to *Methuſelah*'s Age of Years, or only to *Abraham*'s, long after the od, of 175 Years, the World would be too much r-run; or if the Age of Man was limited to that livers other Animals, to ten, twenty, or thirty rs only; the Decays then of Mankind would oo faſt: But at the middle Rate mentioned, Balance is nearly even, and Life and Death p an equal Pace. Which Equality is ſo great harmonious, and ſo manifeſt an Inſtance of the ine Management, that I ſhall ſpend ſome Re- ks upon it. It

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the Reader hath a Mind to ſee a Computation of the eaſe of Mankind, in the three firſt Centuries after the od, he may find two different Ones of the moſt learned hbiſhop *Uſher*, and *Petavius*; together with a Refutation he ſo early Beginning of the *Aſſyrian Monarchy*; as alſo ſons for placing *Abraham* near 1000 Years after the Flood, ur moſt learned Biſhop *Stillingfleet*'s *Orig. Sacr. Book* III. . 4. *Sect.* 9.

) That the common Age of Man hath been the ſame in Ages ſince the World was peopled, is manifeſt from pro- ne, as well as ſacred Hiſtory. To paſs by others: *Plato* d to the Age of 81, and was accounted an old Man. And ſe which *Pliny* reckons up, *l.* 7. *c.* 48. as rare Examples of g Life, may for the moſt part be match'd by our modern Hiſtories;

Hiſtories; eſpecially ſuch as *Pliny* himſelf gave Credit unto. Dr. *Plot* hath given us divers Inſtances in his Hiſtory of Oxfordſhire, *c.* 2. *ſect.* 3. and *c.* 8. *ſect.* 54. and Hiſtory of Staffordſhire, *c.* 8. *ſect.* 91, *&c.* Among others, one is of twelve Tenants of Mr. *Biddulph*'s, that together made 1000 Years of Age. But the moſt conſiderable Examples of aged Perſons among us, is of old *Parre* of *Shropſhire*, who lived 152 Years 9 Months, according to the learned Dr. *Harvey*'s Account, and *Henry Jenkins* of *Yorkſhire*, who lived 169 Years, according to the Account of my learned and ingenious Friend Dr. *Tancred Robinſon*; of both which, with others, ſee *Lowthorp Abridg. Phil. Tranſ. V.* 3. *p.* 306. The great Age of *Parre* of *Shropſhire*, minds me of an Obſervation of the Reverend Mr. *Plaxton*, that in his two Pariſhes of *Kinardſey* and *Donington* in *Shropſhire*, every ſixth Soul was 60 Years of Age, or upwards. *Phil. Tranſ.* No. 310.

And if we ſtep farther North into *Scotland*, we ſhall find divers recorded for their great Age: Of which I ſhall preſent the Reader with only one modern Example of one *Laurence*, who married a Wife after he was 100 Years of Age, and would go out to Sea a Fiſhing in his little Boat, when he was 140 Years old; and is lately dead of no other Diſtemper but mere old Age, ſaith Sir *Rob. Sibbald*, *Prodr. Hiſt. Nat. Scot.* *p.* 44. and *l.* 3. *p.* 4.

As for Foreigners, the Examples would be endleſs; and therefore that of *Joh. Ottele* ſhall ſuffice, who was as famous for his Beard, as for being 115 Years of Age. He was but two *Brabant* Ells $\frac{3}{5}$ high; and his long grey Beard was one Ell $\frac{1}{4}$ long. His Picture and Account may be ſeen in *Ephem. Germ. T.* 3. *Obſ.* 163.

As for the Story *Roger Bacon* tells, of one that lived 900 Years by the Help of a certain Medicine, and many other ſuch Stories, I look upon them as fabulous. And no better than that of the *Wandering Jew*, named *Joh. Buttadæus*, ſaid to have been preſent at our Saviour's Crucifixion; although very ſerious Stories are told of his being ſeen at *Antwerp*, and in *France*, about the Middle of the laſt Century but one; and before in *Ann.* 1542, converſed with by *Paul* of *Eitſen*, Biſhop of *Sleſwick*; and before that, *viz.* in 1228, ſeen and converſed with by an *Armenian* Archbiſhop's Gentleman; and by others at other Times.

If the Reader hath a Mind to ſee more Examples, he may meet with ſome of all Ages, in the learned *Hakewill*'s *Ap.* *p.* 181. where he will alſo find that learned Author's Opinion of the Cauſes of the Brevity and Length of Human Life. The Brevity thereof he attributeth to a too tender Education, ſuckling

It appears from our beſt Accounts of theſe Mat-
rs, that in our *European* Parts (*f*), and I believe
ıc ſame is throughout the World; that, I ſay,
ere is a certain Rate and Proportion in the Pro-
pagation

cking ſtrange Nurſes, too haſty Marriages; but above all, Luxury, high Sauces, ſtrong Liquors, &c. The Longæ-y of the Ancients he aſcribes to Temperance in Meat and rink, anointing the Body, the Uſe of Saffron and Honey, rm Clothes, leſſer Doors and Windows, leſs Phyſick and ore Exerciſe.

(*f*) The Proportions which *Marriages* bear to *Births*, and *rths* to *Burials*, in divers Parts of *Europe*, may be ſeen at an ſy View in this TABLE:

Names of the Places.	Marriages to Births: As	Births to Burials: As
ngland in General.	1 to 4'63	1'12 to 1
ondon.	1 to 4'	1 to 1'1
lantſhire, from 1569, to 1658.	1 to 4'	1'2 to 1
iverton in *Devon*, 1560, to 1649.	1 to 3'7	1'26 to 1
anbrook in *Kent*, 1560, to 1649.	1 to 3'9	1'6 to 1
ynho in *Northamptonſh.* for 118 Years.	1 to 6	1'6 to 1
eeds in *Yorkſhire* for 122 Years.	1 to 3'7	1'07 to 1
arwood in *Yorkſhire* 57 Years.	1 to 3'4	1'23 to 1
Upminſter in *Eſſex* 100 Years.	1 to 4'6	1'08 to 1
rankfort on the *Main* in 1695.	1 to 3'7	1'2 to 1
Old middle & lower *Marck* in 1698.	1 to 3'7	1'9 to 1
Domin. of the K. of *Pruſſia* in 1698.	1 to 3'7	1'5 to 1
Breſlaw in *Sileſia* from 1687, to 1691.		1'6 to 1
Paris in 1670, 1671, 1672.	1 to 4'7	1' to 1'6

Which Table I made from Major *Graunt*'s Obſervations on e Bills of Mortality; Mr. *King*'s Obſervations in the firſt of r. *Davenant*'s Eſſays; and what I find put together by my genious Friend Mr. *Lowthorp*, in his Abridgment, *Vol.* 3. *p.* 68. and my own Regiſter of *Upminſter*. That from *Aynho* Regiſter in *Northamptonſhire*, I had from the preſent Rector, he learned and ingenious Mr. *Waſſe*: And I was promiſed me Accounts from the North, and divers other Parts of his Kingdom; but have not yet received them: Only thoſe

pagation of Mankind: Such a Number marry (*g*), ſo many are born, ſuch a Number die; in Proportion to the Number of Perſons in every Nation, County, or Pariſh. And as to Births, two Things are very conſiderable: One is the Proportion of Males and Females (*h*), not in a wide Proportion, not an uncertain, accidental Number at all Adventures: but nearly equal. Another Thing is, that a few

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of *Leeds* and *Harewood* in *Yorkſhire*, from my curious and ingenious Friend Mr. *Thoresby*.

(*g*) The preceding Table ſhews, that Marriages, one with another, do each of them produce about four Births; not only in *England*, but in other Parts of *Europe* alſo.

And by Mr. *King*'s Eſtimate, (the beſt Computations imagine of any, being derived from the beſt Accounts; ſuch as the Marriage, Birth, Burial-Act, the Poll-Books, &c. by his Eſtimate, I ſay,) about 1 in 104 marry. For he judgeth the Number of the People in *England*, to be about five Millions and a half; of which about 41000 annually marry. As to what might be farther remarked concerning Marriages, in regard of the Rights and Cuſtoms of ſeveral Nations, the Age to which divers Nations limited Marriages, &c. it would be Endleſs, and too much out of the Way to mention them: I ſhall only therefore, for the Reader's Diverſion, take Notice of the Jeer of *Lactantius*, *Quare apud Pœtas ſalaciſſimus Jupiter deſiit liberos tollere? Utrum ſexagenarius factus, & ei Lex Papia fibulam impoſuit?* Lactant. Inſtit. l. 1. c. 16. By which *Lex Papia*, Men were prohibited to marry after 60, and Women after 50 Years of Age.

(*h*) Major *Graunt*, (whoſe Concluſions ſeem to be well-grounded,) and Mr. *King*, diſagree in the Proportions they aſſign to Males and Females. This latter makes in *London* 10 Males to be to 13 Females; in other Cities and Market-Towns, 8 to 9; and in the Villages and Hamlets, 100 Males to 99 Females. But Major *Graunt*, both from the *London* and *Country* Bills, ſaith, there are 14 Males to 13 Females. From whence he juſtly infers, *That Chriſtian Religion, prohibiting Polygamy, is more agreeable to the Law of Nature than* Mahumetiſm, *and others that allow it*, Chap. 8.

This Proportion of 14 to 13, I imagine is nearly juſt, it being agreeable to the Bills I have met with, as well as thoſe in

ew more are born than appear to die, in any cer-
in Place (*i*). Which is an admirable Proviſion
r the extraordinary Emergencies and Occaſions
the World; to ſupply unhealthful Places, where
eath out-runs Life; to make up the Ravages of
eat Plagues, and Diſeaſes, and the Depradations
War, and the Seas; and to afford a ſufficient
umber for Colonies in the unpeopled Parts of
e Earth. Or on the other Hand, we may ſay, that

Mr. *Graunt*. In the 100 Years, for Example, of my own
riſh-Regiſter, although the Burials of Males and Females
re nearly equal, being 636 Males, and 623 Females, in all
t Time; yet there were baptized 709 Males, and but 675
males, which is 13 Females to 13'7 Males. Which Ine-
ality ſhews, not only, that one Man ought to have but
e Wife; but alſo that every Woman may, without Poly-
my, have an Husband, if ſhe doth not bar her ſelf by the
ant of Virtue, by Denial, *&c.* Alſo this Surpluſage of
ales is very uſeful for the Supplies of War, the Seas, and
her ſuch Expences of the Men above the Women.

That this is a Work of the Divine Providence, and not a
atter of Chance, is well made out by the very Laws of
hance, by a Perſon able to do it, the ingenious and learned
r. *Arbuthnot*. He ſuppoſeth *Thomas* to lay againſt *John*, that
eighty two Years running, more Males ſhall be born than
males; and giving all Allowances in the Computation to
omas's ſide, he makes the Odds againſt *Thomas*, that it doth
t happen ſo, to be near five Millions of Millions, of Millions,
Millions to one; but for Ages of Ages (according to the
orld's Age) to be near an infinite Number to one againſt
omas. *Vid. Phil. Tranſ.* No. 328.

(*i*) The foregoing Table ſhews, that in *England* in gene-
l, fewer die than are born, there being but 1 Death to
$\frac{13}{100}$ Births. But in *London* more die than are born. So by
r. *Davenant*'s Table, the Cities likewiſe and Market-Towns
ury 1 $\frac{7}{100}$ to one Birth. But in *Paris* they out-do *London*,
heir Deaths being 1 $\frac{1}{4}$ to one Birth. The Reaſon of which I
onceive is, becauſe their Houſes are more crowded than in
London. But in the Villages of *England*, there are fewer die
han are born, there being but 1 Death to 1 $\frac{17}{100}$ Births. And
et Major *Graunt*, and Dr. *Davenant*, both obſerve, that

that ſometimes thoſe extraordinary Expences of Mankind, may be not only a juſt Puniſhment of the Sins of Men; but alſo a wiſe Means to keep the Balance of Mankind even; as one would be ready to conclude, by conſidering the *Aſiatick* and other the more fertile Countries, where prodigious Multitudes are yearly ſwept away with great Plagues, and ſometimes War; and yet thoſe Countries are ſo far from being waſted, that they remain full of People.

And now upon the whole Matter, What is all this but admirable and plain Management? What can the maintaining, throughout all Ages and Places, theſe Proportions of Mankind, and all other Creatures; this Harmony in the Generations of Men be, but the Work of One that ruleth the World? Is it poſſible that every Species of Animals ſhould ſo evenly be preſerved, proportionate to the Occaſions of the World? That they ſhould be ſo well balanced in all Ages and Places, without the Help of Almighty Wiſdom and Power? How is it poſſible by the bare Rules, and blind Acts of Nature, that there ſhould be any tolerable Proportion; for Inſtance, between Males and Females either

there are more Breeders in *London*, and the Cities and Market-Towns, than are in the Country, notwithſtanding the *London* Births are fewer than the Country; the Reaſon of which ſee in *Graunt*, *Chap.* 7. and *Davenant*, *ubi ſupra*, p. 21.

The laſt Remark I ſhall make from the foregoing Table ſhall be, that we may from thence judge of the Healthfulneſs of the Places there mentioned. If the Year 1698 was the mean Account of the three *Marcks*, thoſe Places bid the faireſt for being moſt Healthful; and next to them *Aynho* and *Cranbrook* for *Engliſh* Towns.

(k) Qu

ther of Mankind, or of any other Creature (*k*); pecially ſuch as are of a ſerine, not of a domeſk Nature, and conſequently out of the Comand and Management of Man? How could Life d Death keep ſuch an even Pace through all the nimal World? If we ſhould take it for granted, at, according to the Scripture Hiſtory, the Vorld had a Beginning, (as who can deny it (*l*)? if we ſhould ſuppoſe the Deſtruction thereof by *Noah*'s Flood: How is it poſſible, after the World as repleniſhed,) that in a certain Number of Years, the greater Increaſes and Doublings of each pecies of Animals; that, I ſay, this Rate of *Doubing* (*m*) ſhould ceaſe; or, that it ſhould be compenſated

(*k*) *Quid loquar, quanta ratio in beſtiis ad perpetuam conſervationem rum generis appareat? Nam primùm aliæ Mares, aliæ Fœminæ ſunt, od perpetuitatis causâ machinata natura eſt.* Cic. de Nat. Deor. 2. c. 51.

(*l*) Although *Ariſtotle* held the Eternity of the World, yet e ſeems to have retracted that Opinion, or to have had a ifferent Opinion when he wrote his *Metaphyſicks*; for in his rſt Book he affirms, that *God is the Cauſe and Beginning of all hings*; and in his Book *de Mundo* he ſaith, *There is no Doubt, t God is the Maker and Conſervator of all Things in the World.* And he *Stoick*'s Opinion is well known, who ſtrenuouſly contend-d, That the Contrivance and Beauty of the Heavens and Earth, and all Creatures, was owing to a Wiſe, Intelligent Aent. Of which *Tully* gives a large Account in his ſecond Book *de Nat. Deor.* in the Perſon of *Balbus*.

(*m*) I have before in *Note* (*g*), obſerved, That the ordinary Rate of the Doubling or Increaſe of Mankind is, that every Marriage, one with another, produces about four Births; but ome have much exceeded that. *Babo*, Earl of *Abenſperg*, had thirty two Sons, and eight Daughters; and being invited o Hunt with the Emperor *Henry* II. and bring but few Servants, brought only one Servant, and his thirty two Sons. To theſe many others might be added; but one of the moſt remarkable Inſtances I have any where met with, is that of Mrs. *Honywood*, mentioned by *Hakewill*, *Camden*, and other

penſated by ſome other Means? That the World ſhould be as well, or better ſtocked than now it is, in 1656 Years [the Time between the Creation and the Flood; this] we will ſuppoſe may be done by the natural Methods of each Species Doubling or Increaſe: But in double that Number of Years, or at this Diſtance from the Flood of 4000 Years, that the World ſhould not be over-ſtocked, can never be made out, without allowing an Infinite Providence.

Authors; but having now before me the Names, with ſome Remarks, (which I received from a pious neighbouring Deſcendant of the ſame Mrs. *Honywood*) I ſhall give a more particular Account than they. Mrs. *Mary Honywood* was Daughter, and one of the Co-heireſſes of *Robert Atwaters*, Eſq; of *Lenham* in *Kent*. She was Born in 1527, Married in *February* 1543, at ſixteen Years of Age, to her only Husband *Robert Honywood*, of *Charing* in *Kent*, Eſq; She died in the ninety-third Year of her Age, in *May* 1620. She had Sixteen Children of her own Body, ſeven Sons and nine Daughters; of which one had no Iſſue, three died young, and the youngeſt was ſlain at *Newport*-Battle, *June* 20, 1600. Her Grand-Children in the ſecond Generation, were one-hundred and fourteen; in the third, two-hundred and twenty-eight; and nine in the fourth Generation. So that ſhe could ſay the ſame that the Diſtich doth, made of one of the *Dalburg*'s Family of *Baſil*;

1 2 3 4
Mater ait Natæ, dic Natæ, filia Natam
5 6
Ut moneat, Natæ, plangere Filiolam.

1 2 3 4
Riſe up Daughter, and go to thy Daughter, for her Daughters
5 6
Daughter hath a Daughter. Mrs. *Honywood* was a very pious Woman, afflicted, in her declining Age, with Deſpair, in ſome Meaſure; concerning which, ſome Divines once diſcourſing with her, ſhe in a Paſſion ſaid, *She was as certainly damned as this Glaſs is broken*, (throwing a *Venice*-Glaſs againſt the Ground, which ſhe had then in her Hand.) But the Glaſs eſcaped breaking, as credible Witneſſes atteſted.

I con-

I conclude then this Obſervation with the Pſalmiſt's Words, *Pſal.* civ. 29, 30. *Thou hideſt thy Face, all Creatures are troubled; thou takeſt away their Breath, they die, and return to their Duſt. Thou ſendeſt forth thy Spirit, they are created; and thou reneweſt the Face of the Earth.*

CHAP. XI.

Of the Food of ANIMALS.

THE preceding Reflection of the *Pſalmiſt*, mindeth me of another Thing in common to Animals, that pertinently falleth next under Conſideration, which is the *Appointment of Food*, mentioned in *Verſe* 27, 28, of the laſt cited *Pſalm* civ. *Theſe* [Creatures] *wait all upon thee, that thou mayeſt give them their Meat in due Seaſon. That thou giveſt them, they gather; thou openeſt thy Hand, they are filled with Good.* The ſame is again aſſerted in *Pſal.* cxlv. 15, 16. *The Eyes of all wait upon thee, and thou giveſt them their Meat in due Seaſon. Thou openeſt thy Hand, and ſatisfieſt the Deſire of every living Thing.*

What the *Pſalmiſt* here aſſerts, affords us a glorious Scene of the Divine Providence and Management. Which, (as I have ſhewed it to Concern it ſelf in other leſſer Things;) ſo we may preſume, doth exert it ſelf particularly in ſo Grand an Affair as that of Food, whereby the animal World ſubſiſts: And this will be manifeſted, and the *Pſalmiſt*'s

Obſervations exemplified, from theſe ſix following Particulars.

I. From the ſubſiſting and maintaining ſuch a large Number of Animals, throughout all Parts of the World.

II. From the proportionate Quantity of Food to the Eaters.

III. From the Variety of Food ſuited to the Variety of Animals; Or, the Delight which various Animals have in different Food.

IV. From the peculiar Food which peculiar Places afford to the Creatures ſuited to thoſe Places.

V. From the admirable and curious Apparatus made for the Gathering, Preparing, and Digeſtion of the Food. And,

VI. *and Laſtly.* From the great Sagacity of all Animals, in finding out and providing their Food.

I. It is a great Act of the Divine Power and Wiſdom, as well as Goodneſs, to provide Food for ſuch a World of Animals (*a*), as every where poſſeſs the Terraqueous Globe; on the dry Land; and in the Sea and Waters; in the torrid and frozen Zones, as well as the temperate. That the temperate Climates, or at leaſt the fertile Valleys, and rich and plentiful Regions of the Earth, ſhould afford Subſiſtance to many Animals, may appear leſs wonderful perhaps: But that in all other the moſt likely Places for Supplies, ſufficient Food ſhould be afforded to ſuch a prodigious Number, and ſo great Variety

(*a*) *Paſtum animantibus large & copioſe natura eum, qui cuique aptus erat, comparavit.* Cic. de Nat. Deo. l. 2. c. 47.

Ille Deus eſt,——qui per totum orbem armenta dimiſit, qui gregibus ubique paſſim vagantibus pabulum præſtat. Senec. de Benef. l. 4. c. 8.

(*b*) Tri-

ty of Beaſts, Birds, Fiſhes, and Inſects; is owing that Being, who hath as wiſely adapted their Bo-es to their Place and Food, as well as carefully ovided Food for their Subſiſtence there.

But I ſhall leave this Conſideration, becauſe it ll be illuſtrated under the following Points; and oceed,

II. To conſider the Adjuſtment of the Quantity Food, in Proportion to the Eaters. In all Pla- there is generally enough; nay, ſuch a Suffici-y, as may be ſtyled a Plenty; but not ſuch a Su-fluity, as to waſte and corrupt, and thereby an-y the World. But that which is particularly re-rkable here, is, that among the great Variety of ods, the moſt uſeful is the moſt plentiful, moſt iverſal, eaſieſt propagated, and moſt patient of eather, and other Injuries. As the herbaceous ters, (for Inſtance) are many, and devour much; the dry-land Surface we find every where almoſt urally carpeted over with Graſs, and other agree-le wholſome Plants; propagating themſelves in a nner every where, and ſcarcely deſtroyable by Weather, the Plough, or any Art. So likewiſe Grain, eſpecially ſuch as is moſt uſeful, how ſily is it cultivated, and what a large Increaſe doth produce? *Pliny*'s Example of Wheat (*b*), is a ficient Inſtance in this Matter; which (as that cu-us Heathen obſerves) being principally uſeful to the

(*b*) *Tritico nihil eſt fertilius: hoc ei natura tribuit, quoniam eo xime alat hominem; utpote cùm è modio, ſi ſit aptum ſolum—— o modii reddantur. Miſit D. Auguſto procurator——ex uno grano ix credibile dictu) 400 paucis minùs germina. Miſit & Neroni ſimi-r 340 ſtipulas ex uno grano.* Plin. Nat. Deor. *l.* 18. *c.* 10.

(*c*) *Sed*

the Support of Man, is eaſily propagated, and great Plenty: And an happy Faculty that is of that it can bear either Extreams of Heat or Co ſo as ſcarce to refuſe any Clime.

III. Another wiſe Proviſion the Creator ha made relating to the Food of Animals, is, that v rious Animals delight in various Food (*c*); ſome Graſs and Herbs; ſome in Grain and Seeds; ſo in Fleſh; ſome in Inſects; ſome in this (*d*), ſome that; ſome more delicate and nice; ſome voraci and catching at any Thing. If all delighted or ſubſiſted only with one Sort of Food, th would not be ſufficient for all; but every Vari chuſing various Food, and perhaps abhorring th which others like, is a great and wiſe Means th every Kind hath enough, and oftentimes ſom what to ſpare.

It deſerves to be reckoned as an Act of the D vine Appointment, that what is wholeſome Fo to one, is nauſeous, and as a Poiſon to anothe what is a ſweet and delicate Smell and Taſte one, is fœtid and loathſome to another: By wh Me

(*c*) *Sed illa quanta benignitas Naturæ, quòd tam multa ad vo dum, tam varia, tam jucunda gignit; neque ea uno tempore anni, ſemper & novitate delectemur & copiâ.* Cic. de Nat. Deor. l. c. 53.

(*d*) *Swammerdam* obſerves of the *Ephemeron-Worms*, that th Food is Clay, and that they make their Cells of the ſa Upon which Occaſion he ſaith of *Moths*, that eat Wooll a Fur, *There are two Things very conſiderable*, 1. *That the Cells make to themſelves, wherein they live, and with which* (*as their* Tortoiſe-like) *they move from Place to Place, they make of the Ma next at Hand.* 2. *That they feed alſo on the ſame, therefore when find their Cells, or rather Coats or Caſes to be made of yellow, gr blue, or black Cloth, you will alſo find their Dung of the ſame Co* Swam. Ephem. vita, publiſhed by Dr. *Tyſon*, *Chap.* 3.

(*e*)

ans all the Provisions the Globe affords are well
oos'd of. Not only every Creature is well provi-
for, but a due Consumption is made of those
ings that otherwise would encumber the World,
n the Way, corrupt, rot, stink and annoy, instead
cherishing and refreshing it. For our most useful
nts, Grain, and Fruits, would mould and rot;
se Beasts, Fowls, and Fishes, which are reckon-
among the greatest Dainties, would turn to Car-
, and poison us: Nay, those Animals which are
ome Carrion, and many other Things that are
some, both on the dry Land, and in the Waters,
uld be great Annoyances, and breed Diseases,
s it not for the Provision which the Infinite
lerer of the World hath made, by causing these
ings to be sweet, pleasant, and wholesome Food
ome Creature or other, in the Place where those
ings fall: To Dogs, Ravens, and other voraci-
Animals, for Instance, on the Earth; and to
acious Fishes, and other Creatures inhabiting
Waters.

Thus is the World, in some Measure, kept sweet
clean, and at the same Time, divers Species of
imals supply'd with convenient Food. Which
ovidence of GOD, particularly in the Supplies
orded the *Ravens*, is divers Times taken Notice
in the Scriptures (*e*); but whether for the Rea-
s now hinted, or any other special Reasons, I
ll not enquire. Thus our Saviour, *Luke* xii. 24.
nsider the Ravens; for they neither sow nor
p, which neither have Storehouse, nor Barn,
d God feedeth them. It is a manifest Argu-
ment

(*e*) *Job* xxxviii, 41, *Psal.* cxlvii. 9. (*f*) *Ari-*

ment of the Divine Care and Providence, in sup-
plying the World with Food and Neceſſaries, tha
the *Ravens*, accounted as unclean, and little re
garded by Man, deſtitute of Stores, and that live b
Accidents, by what falleth here and there; tha
ſuch a Bird, I ſay, ſhould be provided with ſufficie
Food; eſpecially if that be true which *Ariſtotle* (f
Pliny (g), and *Ælian* (h), report of their unna
tural Affection and Cruelty to their Young: "Tha
"they expel them their Neſts as ſoon as they ca
"fly, and then drive them out of the Country".

Thus having conſidered the Wiſe Appointme
of the Creator, in ſuiting the Varicty of Food, t
Variety of Animals: Let us in the

IV. Place, Take a View of the peculiar Food
which particular Places afford to the Creatures in
habiting therein.

It hath been already obſerved (*i*), That ever
Place on the Surface of the Terraqueous Globe,
ſtocked with proper Animals, whoſe Organs o
Life and Action are curiouſly adapted to each re
ſpective Place. Now it is an admirable Act of th
Divine Providence, That every Place affords
proper Food to all the living Creatures therei
All the various Regions of the World, the differe
Climates (*k*), the various Soils, the Seas, th
Water

(f) *Ariſtot. l. 9. c. 31. Hiſt. Animal.*

(g) *Pliny* affirms this of the *Crow* as well as *Raven*: *Cae*
omnes [i. e. Cornices] *ex eodem genere pellunt nidis pullos, ac vola*
cogunt, ſicut & Corvi, qui——robuſtos ſuos fœtus fugant longiùs. N
Hiſt. l. 10. c. 12.

(h) *Var. Hiſt.*

(i) *Chap. 9.*

(k) *Admiranda Naturæ diſpenſatio eſt, ut aliter, alioque modo, to*
pore, & induſtriâ colatur terra ſeptentrionalis, aliter Æthiopia, &
Qu

aters, nay our very Putrefactions, and moſt naſty aces about the Globe, as they are inhabited by ne or other Animal, ſo they produce ſome proper od or other, affording a comfortable Subſiſtence the Creatures living there. I might for Inſtan- (*l*) of this, bring the great Variety of Herbs, uits and Grains on the Earth, the large Swarms Inſects in the Air, with every other Food of Creatures reſiding in the Earth, or flying in the r. But I ſhall ſtop at the *Waters*, becauſe the *almiſt*, in the fore-cited civth *Pſalm*, ſpeaks with ation to the eſpecial Proviſion for the Inhabi- ts of the Waters; and alſo by reaſon that many nd-Animals have their chief Maintenance from nce. Now

ad Aquilonares, hoc certum eſt, in pleriſque agris Veſtrogot horum, e objectâ Meridionali plagæ, Hordeum ſpatio 36 Dierum à ſemine cto maturum colligi, hoc eſt, à fine Junii uſque medium Auguſti, uando celerius. Ea namque maturitas ex ſoli naturâ, aëriſque entiâ, ac humore lapillorum fovente radices, Soleque torrente, neceſ- ò provenit, ut ita naſcatur, ac maturetur, taleſque ſpicæ ſex ordines umero ariſtæ habent. Ol. Mag. Hiſt. l. 15. c. 8. *Prata & ua tantâ luxuriant graminum ubertate ac diverſitate, ut neceſſum inde arcere jumenta, nè nimio herbarum eſu crepent, &c.* Id. ib. 9. c. 36.

(*l*) Among the many noble Contrivances for Food, I can- but attribute that univerſal Aliment, *Bread*, to the Reve- ion, or at leaſt the Inſpiration of the Creator and Conſer- tor of Mankind; not only becauſe it is a Food uſed in all, moſt Parts of the World; but eſpecially becauſe it is of comparable Uſe in the great Work of Digeſtion, greatly iſting the Ferment, or whatever cauſes the Digeſtion of e Stomach. Of which take this Example from the noble r. *Boyle*. " He extracted a *Menſtruum* from Bread alone, that would work on Bodies more compact than many hard Minerals, nay even on Glaſs it ſelf, and do many Things that *Aqua-fortis* could not do ——Yet by no means was this ſo corroſive a Liquor as *Aq. fort.* or as the other *acid Menſtruum*". *Vid.* the ingenious and learned Dr. *Harris*'s *ex. Tech. verbo Menſtruum*, where the way of preparing it ay be met with.

(*n*) *Pſal.*

Now one would think, that the Waters were a very unlikely Element to produce Food for so great a Number of Creatures, as have their Subsistence from thence. But yet how rich a Promptuary is it, not only to large Multitudes of Fishes, but also to many amphibious Quadrupeds, Insects, Reptiles and Birds! From the largest *Leviathan*, which the *Psalmist* saith (*m*) *playeth in the Seas*, to the smallest Mite in the Lakes and Ponds, all are plentifully provided for; as is manifest from the Fatness of their Bodies, and the Gaiety of their Aspect and Actions.

And the Provision which the Creator hath made for this Service in the Waters is very observable, not only by the Germination of divers aquatick Plants there, but particularly by appointing the Waters to be the Matrix of many Animals, particularly of many of the Insect-Kind, not only of such as are peculiar to the Waters, but also of many appertaining to the Air and the Land, who, by their near Alliance to the Waters, delight to be about them, and by that means become a Prey and plentiful Food to the Inhabitants of the Waters. And besides these, what prodigious Shoals do we find of minute Animals, even sometimes discolouring the Waters (*n*)! Of these (not only in the Water, but in the Air and on Land) I have always thought there was some more than ordi-

nary

(*m*) *Psal.* civ. 26.

(*n*) The Insects that for the most part discolour the Waters, are small Insects of the *Shrimp-kind*, called by *Swammerdam*, *Pulex aquaticus arborescens*. These I have often seen numerous in stagnating Waters in the Summer-Months, that they have changed the Colour of the Waters to a pale

deep

ry Uſe intended by the All-wiſe Creator. And ving bent many of my Obſervations that way, I ve evidently found it accordingly to be. For be ry never ſo numberleſs or minute, thoſe Animals ve for Food to ſome Creatures or other. Even ſe Animalcules in the Waters, diſcoverable only h good Microſcopes, are a Repaſt to others re, as I have often with no leſs Admiration than aſure ſeen (*o*). But

p Red, ſometimes a Yellow, according to the Colour y were of. Of this *Swammerdam* hath a pretty Story told by Dr. *Florence Schuyl*, viz. *Se aliquando Studiis intentum, no quodam & horrifico rumore fuiſſe turbatum, & ſemel ad cauſam inquirendam excitatum; verùm ſe vix eum in finem ſurrexiſſe, Ancilla ejus pœne exanimis adcurreret, & multo cum ſingultu re-t, omnem Lugduni* [Batavorum] *aquam eſſe mutatam in ſan-em.* The Cauſe of which, upon Examination he found e only from the numerous Swarms of thoſe *Pulices*. V. mm. Hiſt. Inſect. p. 70.

The Cauſe of this great Concourſe and Appearance of ſe little Inſects, I have frequently obſerved to be to per-n their Coït; which is commonly about the latter end of , and in *June*. At that time they are very venerous, ing and catching at one another; and many of them oined Tail to Tail, with their Bellies inclined one towards ther.

At this time alſo they change their Skin or *Slough*; which I ceive their rubbing againſt one another mightily promo-n. And what if at this Time they change their Quarters? *Book* VIII. *Chap.* 4. *Note* (*f*).

Theſe ſmall Inſects, as they are very numerous, ſo are od to many Water-Animals. I have ſeen not only *Ducks* vel them up as they ſwim along the Waters, but divers In-s alſo devour them, particularly ſome of the middle-ſized *illæ aquaticæ*, which are very voracious Inſects.

(*o*) Beſides the *Pulices* laſt mentioned, there are in the Wa-s other Animalcules very numerous, which are ſcarce viſi-e without a Microſcope. In *May*, and the Summer Months, e green Scum on the Top of ſtagnating Waters, is nothing e but prodigious Numbers of theſe Animalcules: So is ewiſe the green Colour in them, when all the Water ſeems een. Which Animalcules, in all Probability, ſerve for

Food

But now the usual Objection is, that Necessity maketh Use (*p*). Animals must be fed, and they make use of what they find: In the desolate Regions, and in the Waters, for Instance, they feed upon what they can come at; but, when in greater Plenty they pick and chuse.

But this Objection hath been already in some measure answered by what hath been said; which plainly

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Food to the *Pulices Aquatici*, and other the minuter Animals of the Waters. Of which I gave a pregnant Instance in one of the *Nymphæ* of *Gnats*, to my Friend the late admirable Mr. *Ray*, which he was pleased to publish in the last Edition of his *Wisdom of God in the Creation*, p. 430.

(*p*) *Nil adeò quoniam natum'st in Corpore, ututi*
Possemus, sed quod natum'st, id procreat usum.

And afterwards,

Propterea capitur Cibus, ut suffulciat artus,
Et recreet vireis interdatus, atque patentem
Per membra ac venas ut amorem obturet edendi.

And after the same manner he discourseth of Thirst, and divers other Things. *Vid. Lucret. l.* 4. *v.* 831, *&c.*

Against this Opinion of the *Epicureans*, *Galen* ingeniously argues in his Discourse about the Hand. *Non enim Manus ipsæ* (saith he) *hominem artes docuerunt, sed Ratio. Manus autem ipsæ sunt artium organa; sicut Lyra musici——Lyra musicam non docuit, sed est ipsius artifex per eam, quâ præditus est, Rationem: ars autem non potest ex arte absquè organis, ita & una quælibet anima facultates quasdam à suâ ipsius substantiâ obtinet,——Quòd autem corporis particulæ animam non impellunt,——manifestè videre licet, animalia recèns nata consideres, quæ quidem prius agere conantur quàm perfectas habeant particulas. Ego namque Bovis vitulum cornibus petere conantem sæpenumero vidi, antequam ei nata essent cornua. Et pullum Equi calcitrantem, &c. Omne enim animal suæ ipsius Animæ facultates, ac in quos usus partes suæ polleant maximè, non doctore, præsentit.——Quâ igitur ratione dici potest, animalia partium usus à partibus doceri, cùm & antequam illas habeant, hoc cognoscere videantur? Si igitur Ova tria acceperis, unum Aquilæ, alterum Anatis, reliquum Serpentis, & calore modico foveris, animaliaque exclusa; illa quidem alis volare conantia, antequam volare possint; hoc autem revolvi videbis, & serpere affectans, quamvis molle adhuc & invalidum fuerit. Et si, dum perfecta erunt, in unâ eâdemque domo nutricem*

ainly argues Deſign, and a ſuper-intending Wiſ-
m, Power and Providence in this ſpecial Buſineſs
Food. Particularly the different Delight of di-
rs Animals in different Food, ſo that what is
iſeous to one, ſhould be Dainties to another, is
manifeſt Argument, that the Allotment of Food
not a Matter of mere Chance, but entailed to
very Conſtitution and Nature of Animals;
t they chuſe this, and refuſe that, not by Ac-
ent, or Neceſſity, but becauſe the one is a
per Food, agreeable to their Conſtitution, and
appointed by the Infinite Contriver of their
dies; and the other is diſagreeable and injurious
them.

But all this Objection will be found frivolous,
d the Wiſdom and Deſign of the Great Creator
ll demonſtratively appear, if we take a Survey,

V. Of the admirable and curious Apparatus in
Animals, made for the Gathering, Preparing and
geſtion of their Food. From the very firſt En-
nce, to the utmoſt Exit of the Food, we find
ry Thing contrived, made and diſpoſed with
utmoſt Dexterity and Art, and curiouſly adapt-
to the Place the Animal liveth in, and the Food
s to be nouriſhed with.

Let us begin with the *Mouth*. And this we find,
every Species of Animals, nicely conformable
he Uſe of ſuch a Part; neatly ſized and ſhaped
the catching of Prey, for the gathering or re-
ceiving

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de ad locum ſubdialem ducta emiſeris, Aquila quidem ad ſublime; as autem in paludem; —— Serpens verò ſub terrâ irrepet —— Ania quidem mihi videntur Naturâ magis quàm Ratione artem alim [τεχνικὰ artificioſa] *exercere: Apes fingere alveolos*, &c. len de uſu Part. l. c. 3.

ceiving Food (*q*), for the Formation of Speech, and every other ſuch like Uſe (*r*). In ſome Creatures it is wide and large, in ſome little and narrow; in ſome with a deep Inciſure up into the Head (*s*), for the better catching and holding of Prey, and more eaſy Comminution of hard, large and troubleſome Food; in others with a much ſhorter Inciſure, for the gathering and holding of herbaceous Food.

In *Inſects* it is very notable. In ſome forcipated; to catch hold and tear their Prey (*t*). In ſome acu-

(*q*) *Alia dentibus præduntur, alia unguibus, alia roſtri aduncitate carpunt, alia latitudine* [ejuſdem] *ruunt, alia acumine excavant, alia ſugunt, alia lambunt, ſorbent, mandunt, vorant. Nec minor varietas in pedum miniſterio, ut rapiant, diſtrahant, teneant, premant, pendant, tellurem ſcabere non ceſſent.* Plin. Nat. Hiſt. l. 10. c. 71.

(*r*) Becauſe it would be tedious to reckon up the Bones, Glands, Muſcles, and other Parts belonging to the Mouth, it ſhall ſuffice to obſerve, that, for the various Services of Man's Mouth, beſides the Muſcles in common with other Parts, there are five Pair, and one ſingle one proper to the Lips only, as Dr. *Gibſon* reckons them: But my moſt diligent and curious Friend the late Mr. *Cowper*, diſcovered a ſixth Pair. And accordingly Dr. *Drake* reckons ſix Pair, and one ſingle one proper to the Lips, *l.* 3. *c.* 13.

(*s*) *Galen* deſerves to be here conſulted, who excellently argues againſt the caſual Concourſe of the Atoms of *Epicurus* and *Aſclepiades*, from the provident and wiſe Formation of the Mouths of Animals, and their Teeth anſwerable thereto. In Man, his Mouth without a deep Inciſure, with only one canine Tooth on a ſide, and flat Nails, becauſe, ſaith he, *Hic Natura certo ſciebat, ſe animal manſuetum ac civile effingere, cui robur & vires eſſent ex ſapientiâ, non ex corporis fortitudine.* But for *Lions*, *Wolfs* and *Dogs*, and all ſuch as are called Καρχαροδοντες, (or having ſharp, ſerrated Teeth) their Mouths are large, and deep cut; Teeth ſtrong and ſharp, and their Nails ſharp, large, ſtrong and round, accommodated to holding and tearing. *Vid. Galen. de Uſ. Part. l.* 11. *c.* 9.

(*t*) Among Inſects, the *Squillæ aquaticæ*, as they are very rapacious, ſo are accordingly provided for it: Particularly the

culeated, to pierce and wound Animals (*u*), and ſuck their Blood. And in others ſtrongly rigged with Jaws and Teeth, to gnaw and ſcrape out their Food,

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he *Squilla aquatica maxima recurva* (as I call it) who hath omewhat terrible in its very Aſpect, and in its Poſture in he Water, eſpecially its Mouth, which is armed with long, harp Hooks, with which it boldly, and greedily catcheth ny thing in the Waters, even one's Fingers. When they ave ſeized their Prey, they will ſo tenaciouſly hold it with heir forcipated Mouth, that they will not part therewith, ven when they are taken out of the Waters, and jumbled bout in one's Hand. I have admired at their peculiar way f taking in their Food; which is done by piercing their rey with their *Forcipes* (which are hollow) and ſucking the ice thereof through them.

The *Squilla* here mentioned, is the firſt and ſecond in *ouffet's Theat. Inſect. l.* 2. *c.* 37.

(*u*) For an Inſtance of Inſects endued with a Spear, I ſhall, r its Peculiarity, pitch upon one of the ſmalleſt, if not e very ſmalleſt of all the *Gnat*-kind, which I call, *Culex inimus nigricans maculatus ſanguiſuga.* Among us in *Eſſex*, they e called *Nidiots*; by *Mouffet*, *Midges*. It is about one tenth f an Inch, or ſomewhat more, long, with ſhort *Antennæ*, lain in the Female, in the Male feather'd, ſomewhat like Bottle-Bruſh. It is ſpotted with blackiſh Spots, eſpecially n the Wings, which extend a little beyond the Body. It mes from a little ſlender Eel-like Worm, of a dirty white olour, ſwimming in ſtagnating Waters by a wrigling Mo-on; as in *Fig.* 5.

Its *Aurelia* is ſmall, with a black Head, little ſhort Horns, ſpotted, ſlender, rough Belly. *Vid. Fig.* 6. It lies quietly o the top of the Water, now and then gently wagging it ſelf is way and that.

Theſe *Gnats* are greedy Blood-Suckers, and very trouble-me, where numerous; as they are in ſome Places near the *hames*, particularly in the Breach-Waters that have lately efallen near us, in the Pariſh of *Dagenham*; where I found em ſo vexatious, that I was glad to get out of thoſe Marſhes. ea, I have ſeen Horſes ſo ſtung with them, that they have ad Drops of Blood all over their Bodies, where they were ounded by them.

I have given a Figure (in *Fig.* 7.) and more particular eſcription of the *Gnats*, becauſe, although it be common,

Food, to carry Burdens (*w*), to perforate the Earth, yea the hardeſt Wood, yea even Stones themſelves, for Houſes (*x*) to themſelves, and Neſts for their young.

And laſtly, in *Birds* it is no leſs remarkable. In the firſt Place, it is neatly ſhaped for piercing the Air, and making Way for the Body through the airy Regions. In the next Place, it is hard and horny, which is a good Supplement for the want of Teeth, and cauſeth the Bill to have the Uſe and Service of the Hand. It's hooked Form is of great Uſe to the rapacious Kind (*y*), in catching and holding their Prey, and in the Comminution thereof by tearing; to others it is no leſs ſerviceable to their Climbing, as well as neat and nice Comminution of their Food (*z*). Its extraordinary Length and Slenderneſs is very uſeful to ſome, to ſearch and grope

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it is no where taken notice of by any Author I know, except *Mouffet*, who, I ſuppoſe, means theſe *Gnats*, which he calls *Midges*, *c.* 13. *p.* 82.

(*w*) *Hornets* and *Waſps* have ſtrong Jaws, toothed, wherewith they can dig into Fruits, for their Food; as alſo gnaw and ſcrape Wood, whole Mouthfuls of which they carry away to make their Combs. *Vid. infr. Chap.* 13. *Note* (*c*).

(*x*) Monſieur *de la Voye* tells of an ancient Wall of Free-Stone in the *Benedictines-Abbey* at *Caen* in *Normandy*, ſo eaten with Worms, that one may run ones Hand into moſt of the Cavities: That theſe Worms are ſmall and black, lodging in a greyiſh Shell; that they have large flattiſh Heads, a large Mouth, with four black Jaws, *&c. Phil. Tranſ.* No. 18.

(*y*) *Pro iis* [Labris] *cornea & acuta Volucribus Roſtra. Eadem rapto viventibus adunca: collecto, recta: herbas ruentibus limumque lata, ut Suum generi. Jumentis vice manûs ad colligenda pabula: et apertiora laniatu viventibus.* Plin. Nat. Hiſt. l. 11. c. 37.

(*z*) *Parrots* have their Bills nicely adapted to theſe Services, being hooked, for climbing and reaching what they have occaſion for; and the lower Jaw being compleatly fitted to

rope for their Food in mooriſh Places (*aa*); as s Length and Breadth is to others to hunt and earch in muddy Places (*bb*): And the contrary orm, namely, a thick, ſhort, and ſharp-edged ill, is as uſeful to other Birds, who have occaſion husk and flay the Grains they ſwallow. But it ould be endleſs, and tedious, to reckon up all the arious Shapes, and commodious Mechaniſm of l; the Sharpneſs and Strength of thoſe who have ccaſion to perforate Wood and Shells (*cc*); the lenderneſs and Neatneſs of ſuch as pick up ſmall nſects; the Croſs-form of ſuch as break up Fruits *dd*); the compreſſed Form of others (*ee*), with many

e Hooks of the upper, they can as minutely break their ood, as other Animals do with their Teeth.

(*aa*) Thus in *Woodcocks*, *Snipes*, &c. who hunt for Worms mooriſh Ground, and, as Mr. *Willughby* ſaith, live alſo on e fatty unctuous Humour they ſuck out of the Earth. So lſo the Bills of *Curlews*, and many other Sea-Fowl, are very ng, to enable them to hunt for the Worms, &c. in the ands on the Sea-ſhore, which they frequent.

(*bb*) *Ducks*, *Geeſe*, and divers others, have ſuch long broad Bills, to quaffer and hunt in Water and Mud; to which we ay reckon the uncouth Bill of the *Spoon-Bill*: but that hich deſerves particular Obſervation in the Birds named in heſe two laſt Notes is, the Nerves going to the end of their Bills, enabling them to diſcover their Food out of Sight; of hich ſee *Book* VII. *Chap.* 2. *Note* (*e*).

(*cc*) The *Picus viridis*, or *Green-Woodſpite*, and all the *Wood-Peckers* have Bills curiouſly made for digging Wood, ſtrong, ard, and ſharp. A neat Ridge runs along the top of the reen *Wood-Pecker*'s Bill, as if an Artiſt had deſigned it for Strength and Neatneſs.

(*dd*) The *Loxia*, or *Croſs-Bill*, whoſe Bill is thick and ſtrong, with the Tips croſſing one another; with great Readineſs breaks open Fir-cones, Apples, and other Fruit, to come at their Kernels, which are its Food, as if the croſſing of the Bill was deſigned for this Service.

(*ee*) The *Sea-Pie* hath a long, ſharp, narrow Bill, compreſſed ſide-ways, and every way ſo well adapted to the raiſing

many other curious and artificial Forms, all ſuited to the Way of Living, and peculiar Occaſions of the ſeveral Species of Birds. Thus much for the Mouth.

Let us next take a ſhort View of the *Teeth* (*ff*). In which their peculiar Hardneſs (*gg*) is remarkable, their Growth (*hh*) alſo, their firm Inſertion and Bandage in the Gums and Jaws, and their various Shape and Strength, ſuited to their various Occaſion and Uſe (*ii*); the foremoſt weak and farther

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Limpets from the Rocks (which are its chief, if not only Food) that Nature (or rather the Author of Nature) ſeems to have framed it purely for that Uſe.

(*ff*) *Thoſe Animals which have Teeth on both Jaws, have but one Stomach; but moſt of thoſe which have no upper Teeth, or none at all, have three Stomachs; as in Beaſts, the Paunch, the Read, and the Feck; and in all granivorous Birds, the Crop, the Echinus and the Gizard. For as chewing is an eaſy Digeſtion, ſo is ſwallowing whole to that which is more laborious.* Dr. *Grew's* Coſmol. Sacr. c. 5. Sect. 24.

(*gg*) *J. Peyer* ſaith, the Teeth are made of convolved Skins hardened; and if we view the Grinders of *Deer*, *Horſes*, *Sheep*, &c. we ſhall find great Reaſon to be of his Mind. His Obſervations are, *Mirum autem eos* (i. e. *Dentes*) *cùm primùm è pelliculis imbricatim convolutis & muco viſcido conſtarent, in tantam dirigeſcere ſoliditatem, quæ oſſa cuncta ſuperet. Idem fit etiam in Oſſiculis Ceraſorum*, &c.——*Separatione factâ, per membranas conditur Magna locellis, quos formant laminæ tenues, ac duriuſculæ ad Dentis figuram anteà divinitùs compoſitæ.* J. Peyer Merycol. l. 2. c. 8.

(*hh*) *Qui autem* (i. e. *Dentes*) *renaſcuntur, minimè credendi ſunt ex facultate aliquâ plaſticâ Brutorum denuo formari, ſed latentes tantummodo in conſpectum producuntur augmento molis ex effluente ſucco.* Id. ibid.

(*ii*) From theſe, and other like Conſiderations of the Teeth, *Galen* infers, That they muſt needs be the Work of ſome Wiſe, Provident *Being*; not *Chance*, nor a fortuitous Concourſe of *Atoms*. For the Confirmation of which he puts the Caſe, That ſuppoſe the Order of the Teeth ſhould have been inverted, the *Grinders* ſet in the room of the *Inciſors*, &c. (which might as well have been, had not the Teeth been

farthest from the Center, as being only Preparers to the rest; the others being to grind and mince, are accordingly made stronger, and placed nearer the Center of Motion and Strength. Likewise their various Form (*kk*), in various Animals is considerable, being all curiously adapted to the peculiar Food (*ll*), and Occasions of the several Species of Animals (*mm*). And lastly, the temporary Defect

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been placed by a wise Agent) in this Case, What Use would the Teeth have been of? What Confusion by such a slight Error in their Disposal only? Upon which he argues, *At si vis choream hominum* 32 (the Number of the Teeth) *ordine disposuit, eum ut hominem industrium laudaremus: cùm verò Dentium choream Natura tam bellè exornârit, nonne ipsam quoque laudabimus?* And then he goes on with the Argument, from the Sockets of the Teeth, and their nice fitting in them, which being no less accurately done, than what is done by a Carpenter, or Stone-Cutter, in fitting a Tenon into a Mortice, doth as well infer the Art and Act of the Wise *Maker* of Animal Bodies, as the other doth the Act and Art of Man. And so he goes on with other Arguments to the same Effect. *Galen. de Us. Part. l.* 11. *c.* 8.

(*kk*) A curious Account of this may be found in an *Extract of a Letter concerning the Teeth of divers Animals*. Printed at *Paris*, in *M. Vauguion*'s Compleat Body of Chirurg. Oper. Chap. 53.

(*ll*) As it hath been taken Notice of, that various Animals delight in various Food; so it constantly falls out, that their Teeth are accordingly fitted to their Food; the rapacious to catching, holding and tearing their Prey; the herbaceous to Gathering and Comminution of Vegetables: And such as have no Teeth, as Birds, their Bill, Craw and Gizard, are assisted with Stones, to supply the defect of Teeth. But the most considerable Example of this Kind is in some Families of the Insect-Tribes, as the *Papillio-Kind*, &c. who have Teeth, and are voracious, and live on tender Vegetables in their *Nympha*, or *Caterpillar-State*, when they can only creep; but in their mature *Papillio-State*, they have no Teeth, but a *Proboscis*, or *Trunk*, to suck up Honey, &c. their Parts for gathering Food, as well as their Food being changed, as soon as they have Wings to enable them to fly to it.

(*mm*) It is remarkable in the Teeth of Fishes, that in some they

fect of them (*nn*), is no leſs obſervable in Children, and ſuch young Creatures, where there is no Occaſion for them; but they would be rather an Annoyance to the tender Nipples and Breaſts.

From the Teeth, the grand Inſtruments of Maſtication; let us proceed to the other miniſterial Parts. And here the *Parotid*, *Sublingual*, and *maxillary Glands*; together with thoſe of the Cheeks and Lips, are conſidrable; all lodged in the moſt convenient Places about the Mouth and Throat, to afford that noble digeſtive ſalival Liquor, to be mixed with the Food in Maſtication, and to moiſten and lubricate the Paſſages, to give an eaſie deſcent to the Food. The commodious Form alſo of the Jaws, deſerves our Notice: together with the ſtrong Articulation of the lowermoſt, and its Motion. And laſtly, the curious Form, the great Strength, the convenient Lodgment and Situation of the ſeveral Muſcles and Tendons (*oo*), all

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they are ſharp, as alſo jointed, ſo as to fall back, the better to catch and hold their Prey, and to facilitate its Paſſage into the Stomach: So in others they are broad and flat, made to break the Shells of Snails and Shell-Fiſh devoured by them. Theſe *Teeth*, or *Breakers*, are placed, in ſome, in the Mouth; in ſome, in the Throat; and in *Lobſters*, &c. in the Stomach it ſelf; in the bottom of whoſe Stomachs are three of thoſe *Grinders*, with peculiar Muſcles to move them.

(*nn*) What is there in the World can be called an Act of Providence and Deſign, if this temporary Defect of Teeth be not ſuch: That Children, for Inſtance, ſhould have none whilſt they are not able to uſe them, but to hurt themſelves, or the Mother; and that at the very Age when they can take in more ſubſtantial Food, and live without the Breaſt, and begin to need Teeth, for the ſake of Speech; that then, I ſay, their Teeth ſhould begin to appear, and gradually grow, as they more and more ſtand in need of 'em.

(*oo*) It would be endleſs to particularize here, and therefore

miniſtring to this ſo neceſſary an Act of Life, as Maſtication is; they are ſuch Contrivances, ſuch Works, as plainly ſet forth the Infinite Workman's Care and Skill.

Next to the Mouth, the *Gullet* preſenteth it ſelf; every Creature well-ſiz'd to the Food it hath occaſion to ſwallow; in ſome but narrow, in others as large and extenſive (*pp*); in all exceeding-remarkable for the curious Mechaniſm of its muſcles, and the artificial Decuſſation and Poſition of their Fibres (*qq*). And

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ere I ſhall refer to the Anatomiſts; among the reſt, particularly to *Galen*, for the ſake of his Deſcant upon this Subject. Who having deſcribed the great Accuracy of the Contrivance and Make of theſe Parts, he ſaith, *Haud ſcio an hominum ſit ſortem ad Fortunam opificem id revocare: alioqui quid tandem erit, quod cum Providentiâ atque Arte efficitur? Omnino enim hoc ei contrarium eſſe debet, quod caſu ad fortuitò fit.* Galen. de Uſ. Part. lib. 11. c. 7. *ubi plura.*

(*pp*) *The Bore of the Gullet is not in all Creatures alike anſwerable to the Body or Stomach. As in the* Fox, *which both feeds on Bones, and ſwallows whole, or with little chewing; and next in a* Dog, *and other ravenous Quadrupeds, 'tis very large,* viz. *to prevent a Contuſion there. Next in a* Horſe, *which though he feeds on Graſs, yet ſwallows much at once, and ſo requires a more open Paſſage. But in a* Sheep, Rabbit, *or* Ox, *which bite ſhort, and ſwallow leſs at once, 'tis ſmaller. And in a* Squirrel, *ſtill leſſer, both becauſe he eats fine, and to help him from diſgorging his Meat upon his deſcending Leaps. And ſo in* Rats *and* Mice, *which often run along Walls, with their Heads downwards.* Dr. *Grew's* Comp. Anat. of Stom. and Guts, chap. 5.

(*qq*) Of this ſee Dr. *Willis's Pharm. Rat.* Part 1. Sect. 1. c. 2. *Bauhino* alſo, and *Peyer Mery*, l. 2.

The Deſcription theſe give of the muſcular Part of the Gullet, the late ingenious and learned Dr. *Drake* ſaith is very exact in Ruminants, but not in Men. *In Men, this Coat* (the ſecond of the Gullet) *conſiſts of two fleſhy* Lamellæ, *like two diſtinct Muſcles. The outward being compoſed of ſtrait longitudinal Fibres.——The inner Order of Fibres is annular, without any obſervable Angles.——The Uſe of this Coat, and theſe Orders of Fibres, is to promote Deglutition; of which the Longitudinal,——ſhorten the* Oeſophagus,

And now we are arriv'd to the grand Receptacle of the Food, the *Stomach*; for the most Part as various as the Food to be convey'd thereinto. And here I might describe the admirable Mechanism of its Tunicks, Muscles, Glands, the Nerves, Arteries, and Veins (*rr*); all manifesting the super-eminent Contrivance and Art of the Infinite Workman (*ss*); they being all nicely adjusted to their respective Place, Occasion and Service. I might also insist upon that most necessary Office of *Digestion*; and here consider that wonderful Faculty of the Stomachs of all Creatures, to dissolve (*tt*) all the several Sorts of Food appropriated to their Species; even sometimes Things of that Consistency as seem Insoluble (*uu*); especially by such as seem-

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phagus, *and so make its Capacity larger, to admit of the Matter to be swallowed. The Annular, on the contrary, contract the Capacity, and closing behind the descending Aliment, press it downwards.* Drake Anat. vol. 1. l. 1. c. 9.

(*rr*) See *Willis*, ibid. *Cowper's Anat. Tab.* 35. and many other Authors.

(*ss*) *Promptuarium autem hoc, alimentum universum excipiens Divinum, non Humanum sit opificium.* Galen. de Us. Part. l. 4. c. 1.

(*tt*) *How great a Comprehension of the Nature of Things, did it require, to make a* Menstruum, *that should corrode all sorts of Bodies coming into the Stomach, and yet not the Stomach it self, which is of Flesh?* Dr. *Grew's* Cosmol. Sacr. c. 4.

(*uu*) The Food of the *Castor* being oftentimes, if not always, dry Things, and hard of Digestion, such as the Root and Bark of Trees, 'tis a wonderful Provision made in the Creature's Stomach, by the digestive Juice lodged in the various little Cells there. A Description of whose admirable Structure and Order may be found in *Blasius* from *Wepfer*, concerning which he saith, *In quibus Mucus reconditus, non secus ac Mel in Favis.——Nimirum quia Castoris alimentum exsuccum, & cibatu difficillimum est, sapientissimus & summè admirandus in suis operibus rerum Conditor, D. O. M. ipsi pulcherrimâ istâ & affabre fa-*

mingly ſimple and weak *Menſtruums* as we d in their Stomachs: But I ſhall only give theſe hings a bare mention, and take more peculiar otice of the ſpecial Proviſion made in the parti-lar Species of Animals, for the Digeſtion of that cial Food appointed them.

And in the firſt Place it is obſervable, that, in ery Species of Animals, the Strength and Size their Stomach (*ww*) is conformable to their od. Such whoſe Food is more delicate, tender, d nutritive, have commonly this Part thinner, aker, and leſs bulky; whereas ſuch whoſe Ali-nt is leſs nutritive, or whoſe Bodies require larg-Supplies to anſwer their Bulk, their Labours, d waſte of Strength and Spirits, in them it is ge and ſtrong.

Another very remarkable Thing in this Part, is, Number of Ventricles in divers Creatures. In many

ara benigniſſimè proſpexit, ut nunquam deeſſet Fermentum, quod ad ndum, & comminuendum alimentum durum & aſperum par foret. . Blaſ. Anat. Animal. c. 10. *Confer etiam Act. Erud. Lipſ.* n. 1684. p. 360.

Moſt of our Modern Anatomiſts and Phyſicians attribute geſtion to a diſſolving *Menſtruum*; but Dr. *Drake* takes it e rather from fermentative, diſſolving Principles in the ment it ſelf, with the Concurrence of the Air and Heat of Body; as in Dr. *Papin's Digeſter. Vid. Dr. Anat. vol.* 1. *c.* 14.

(*ww*) *All carnivorous Quadrupeds have the ſmalleſt Ventricles, going fartheſt. Thoſe that feed on Fruits, and Roots, have them middle Size. Yet the* Mole, *becauſe it feeds unclean, hath a very t one.* Sheep *and* Oxen, *which feed on Graſs, have the greateſt. the* Horſe (*and for the ſame Reaſon the* Coney *and* Hare) *though minivorous, yet comparatively have but little ones. For that a* Horſe *ade for Labour, and both this, and the* Hare, *for quick and conti-d Motion; for which, the moſt eaſy Reſpiration, and ſo the freeſt tion of the Diaphragm is very requiſite; which yet could not be, ld the Stomach lie big and cumberſome upon it, as in* Sheep *and* en it *doth.* Grew, ib. Chap. 6.

(*xx*) The

many but one; in ſome two or more (*xx*). In ſuch as make a ſufficient Comminution of the Food in the Mouth, one ſuffices. But where Teeth are wanting, and the Food dry and hard, (as in granivorous Birds), there the Defect is abundantly ſupply'd by one thin membranaceous Ventricle to receive and moiſten the Food, and another thick, ſtrong, muſcular one, to grind and triture (*yy*) it. But in ſuch Birds, and other Creatures whoſe Food is not Grain, but Fleſh, Fruits, Inſects, or partly one, partly the other, there their Stomachs are accordingly conformable to their Food (*zz*), ſtronger or weaker, membranaceous or muſcular.

But as remarkable a Thing as any in this Part of Animals, is, the curious Contrivance and Fabrick of the ſeveral Ventricles of ruminating Creatures. The very Act it ſelf of *Rumination*, is an excellent Proviſion for the compleat Maſtication of the Food at the Reſting, leiſure Times of the Animal. But the Apparatus for this Service, of divers Ven-

tricles

(*xx*) The *Dromedary* hath four Stomachs, one whereof peculiarly endowed with about twenty Cavities, like Sacks in all Probability for the holding of Water. Concerning which, ſee *Book* VI. *Chap.* 4. *Note* (*a*).

(*yy*) To aſſiſt in which Office, they ſwallow ſmall angular Stones, which are to be met with in the Gizards of all granivorous Birds; but in the Gizard of the *Iynx*, or *Wryneck*, which was full only of *Ants*, I found not one Stone. So in that of the *Green Wood-Pecker* (full of *Ants* and Tree-Maggots) there were but few Stones.

(*zz*) *In moſt carnivorous Birds, the third Ventricle is Membranous, where the Meat is concocted, as in a Man: Or ſomewhat Tendinous, as in an* Owl; *as if it were made indifferently for Fleſh, or other Meat, as he could meet with either. Or moſt thick and tendinous, called the Gizard; wherein the Meat, as on a Mill, is ground to Pieces.* Grew *ubi ſupra*, Chap. 9.

(*aaa*)

icles for its various Uſes and Purpoſes, together ith their curious Mechaniſm, deſerves great Adiration (*aaa*).

Having thus far purſu'd the Food to the Place, here by its Reduction into Chyle, it becomes a oper Aliment for the Body; I might next trace through the ſeveral Mæanders of the *Guts*, the *lacteals*, and ſo into the *Blood* (*bbb*), and afterwards

(*aaa*) It would be much too long a Taſk to inſiſt upon it re as it deſerves, and therefore concerning the whole Buſiſs of Rumination, I ſhall refer to *J. Conr. Peyeri Merycolog. de Ruminantibus & Ruminatione Commentar.* where he largetreateth of the ſeveral Ruminating Animals, of the Parts niſtring to this Act, and the great Uſe and Benefit thereunto them.

(*bbb*) There are too many Particulars to be inſiſted on, obvable in the Paſſages of the *Chyle*, from the Guts to the *ft Subclavia Vein*, where it enters into the Blood; and therefore I ſhall only, for a Sample of this admirable OEconoy, take Notice of ſome of the main and more general atters. And,

1. After the Food is become Chyle, and gotten into the uts, it is an excellent Proviſion made, not only for its Paſge through the Guts, but alſo for its Protruſion into the *cteals*, by the *Periſtaltick* Motion, and *Valvulæ Conniventes* of e Guts. 2. It is an admirable Proviſion, that the Mouths the *Lacteals*; and indeed the *Lacteals primi generis* themſelves e ſmall and fine, not wider than the *Capillary Arteries* are, ſt by admitting Particles of the Nouriſhment groſſer than e *Capillaries*, dangerous Obſtructions might be thereby proced. 3. After the Reception of the Aliment into the *Lacls primi generis*, it is a noble Proviſion for the Advancement its Motion, that in the *Meſenterick Glands*, it meets with me of the *Lymphæ-Ducts*, and receives the Impregnations of e *Lympha*. And paſſing on from thence, it is no leſs Adntage. 4. That the *Lacteals*, and *Lymphæ-Ducts* meet in e *Receptaculum Chyli*, where the Aliment meeting with more the *Lympha*, is made of a due Conſiſtence and Temperaent, for its farther Advancement through the *Thoracick Duct*, nd ſo into the *Left Subclavian Vein* and Blood. Laſtly, This *horacick Duct* it ſelf is a Part of great Conſideration. For

(as

wards into the very Habit of the Body: I might also take Notice of the Separation made in the *Inteſtines*, of what is nutritive, (which is received) and what is feculent, (being ejected;) and the Impregnations there from the *Pancreas* and the *Gall* and after it hath been ſtrained through thoſe curious Colanders, the *lacteal Veins*, I might also obſerve its Impregnations from the *Glands* and *Lymphæducts*; and, to name no more, I might farther View the exquiſite Structure of the Parts miniſtring to all theſe delicate Offices of Nature; particularly the artificial Conformation of the Inteſtines might deſerve a ſpecial Enquiry, their Tunicks, Glands, Fibres traverſing one another (*ccc*), and periſtaltick Motion in all Creatures; and their cochleous Paſſage (*ddd*) to retard the Motion of the

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(as Mr. *Cowper* ſaith) *If we conſider in this Duct its ſeveral Diviſions and Inoſculations, its numerous Valves looking from below upwards, in advantageous Situation between the great Artery and* Vetebræ *of the Back, together with the Ducts diſcharging their refluent* Lympha *from the Lungs, and other neighbouring Parts, we ſhall find all conduce to demonſtrate the utmoſt Art of Nature uſed in furthering the ſteep and perpendicular Aſcent of the Chyle.* Anat. Introduct.

(*ccc*) Theſe, although noble Contrivances and Works of God, are too many to be inſiſted on, and therefore I ſhall refer to the Anatomiſts, particularly Dr. *Willis Pharmacent. Dr. Cole*, in *Phil. Tranſ.* No. 125. and Mr. *Cowper*'s elegant Cut in *Anat. Tab.* 34, 35. and *Append. Fig.* 39, 40.

(*ddd*) In the *Thornback*, and ſome other Fiſhes, it is a very curious Proviſion that is made to ſupply the Paucity and Brevity of the Guts; by the Perforation of their ſingle Gut, going out ſtrait along, but round like a Pair of Winding-Stairs; ſo that their Gut, which ſeems to be but a few Inches long, hath really a Bore of many Inches. But of theſe, and many other noble Curioſities and Diſcoveries in Anatomy, the Reader will, I hope, have a better and larger Account from the curious and ingenious Dr. *Douglas*, who is labouring in thoſe Matters.

(*eee*) *Quæ*

e Chyle, and to make amends for the Shortneſs the Inteſtines, in ſuch Creatures who have but e Gut; together with many other Accommoda-ns of Nature in particular Animals that might mentioned. But it ſhall ſuffice to have given ly a general Hint of thoſe curious and admirable orks of GOD. From whence it is abundantly nifeſt, how little Weight there is in the former eiſtical Objection. Which will receive a fur-r Confutation from the

VI. and laſt Thing relating to Food, that I ſhall ak of, namely, *The great Sagacity of all Ani-ls, in finding out and providing their Food.* Man, perhaps, we may not find any Thing very mirable, or remarkable in this Kind, by Means his Reaſon and Underſtanding, and his Supre-acy over the inferiour Creatures; which anſwer-all his Occaſions relating to this Buſineſs: t then even here the Creator hath ſhewed his ill, in not over-doing the Matter; in not provid-g Man with an unneceſſary Apparatus, to effect er and over again what is feaſible, by the Reach his Underſtanding, and the Power of his Au-ority.

But for the inferiour Creatures, who want Rea-n, the Power of that natural Inſtinct, that Saga-y (*eee*) which the Creator hath imprinted upon em, do amply compenſate that Defect. And re we ſhall find a glorious Scene of the Divine Wiſdom,

(*eee*) *Quibus beſtiis erat is cibus, ut alius generis beſtiis veſceren-r, aut vires natura dedit, aut celeritatem: data eſt quibuſdam etiam achinatio quædam, atque ſolertia,* &c. Cic. de Nat. Deor. l. c. 48.

(*fff*) Among

Wiſdom, Power, Providence and Care, if we view the various Inſtincts of Beaſts, great and ſmall, Birds, Inſects, and Reptiles (*fff*). For among every Species of them, we may find notable Acts of Sagacity, or Inſtinct, proportional to their Occaſions for Food. Even among thoſe whoſe Food is near at Hand, and eaſily come at; as Graſs and Herbs; and conſequently have no great need of Art to diſcover it; yet, that Faculty of their accurate Smell and Taſte, ſo ready at every turn, to diſtinguiſh between what is ſalutary, and what pernicious (*ggg*), doth juſtly deſerve Praiſe. But for ſuch Animals, whoſe Food is not ſo eaſily come at, a Variety of wonderful Inſtinct may be met with, ſufficient to entertain the moſt curious Obſerver. With what entertaining Power and Artifice do ſome Creatures hunt (*hhh*), and purſue their Game

and

(*fff*) Among Reptiles that have a ſtrange Faculty to ſhift for Food, &c. may be reckoned *Eels*, which, although belonging to the Waters, can creep on the Land from Pond to Pond, &c. Mr. *Moſely* of *Moſely*, ſaw them creep over the Meadows, like ſo many Snakes from Ditch to Ditch; which he thought, was not only for bettering their Habitation, but alſo to catch Snails in the Graſs. *Plot*'s Hiſtory of *Staffordſhire* c. 7. ſect. 32.

And as early as the Year 1125, the Froſt was ſo very intenſe, that the *Eels* were forced to leave the Waters, and were frozen to Death in the Meadows. *Vide Hakewill*'s *Apol.* l. 2. chap. 7. ſect. 2.

(*ggg*) *Enumerare poſſum, ad paſtum capeſſendum conficiendumque quæ ſit in figuris animantium & quàm ſolers, ſubtiliſque deſcriptio partium, quàmque admirabilis fabrica membrorum. Omnia enim quæ intus incluſa ſunt, ita nata, atque ita locata ſunt, ut nihil eorum ſupervacaneum ſit, nihil ad vitam retinendam non neceſſarium. Dedit autem eadem Natura belluis & ſenſum, & appetitum, ut altero conatum haberent ad naturales paſtus capeſſendos; altero ſecernerent peſtifera à ſalutaribus.* Cic. de Nat. Deor. *l.* 2. c. 37. See *Book* IV. *Chap.* 4.

(*hhh*) It would be Endleſs to give Inſtances of my own and others

d Prey! And others watch and way-lay theirs *ii*) ! With what prodigious Sagacity do others ope for it under Ground, out of Sight, in mooriſh aces, in Mud and Dirt (*kkk*); and others dig and

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ers Obſervations, of the prodigious Sagacity of divers A-nals in Hunting, particularly Hounds, Setting-Dogs, &c. e therefore ſhall ſuffice of Mr. *Boyle*'s, viz. *A Perſon of Quality —to make a Trial, whether a young Blood-Hound was well inſtruct-——cauſed one of his Servants ——to walk to a Town four Miles and then to a Market-Town three Miles from thence——The Dog, hout ſeeing the Man he was to purſue, followed him by the Scent to above-mentioned Places, notwithſtanding the Multitude of Market-ple that went along in the ſame Way, and of Travellers that had aſion to croſs it. And when the Blood-Hound came to the chief Mar-Town, he paſſed through the Streets, without taking Notice of any he People there, and left not till he had gone to the Houſe, where Man he ſought reſted himſelf, and found him in an upper Room, to Wonder of thoſe that followed him.* Boyl. determ. Nat. of Ef-y. *Chap.* 4.

(*iii*) There are many Stories told of the Craft of the *Fox*, to mpaſs his Prey; of which *Ol. Magnus* hath many ſuch, as gning the Barking of a *Dog*, to catch Prey near Houſes; gning himſelf dead, to catch ſuch Animals as come to feed on him; laying his Tail on a Waſp-Neſt, and then rubbing hard againſt a Tree, and then eating the *Waſps* ſo killed; dding himſelf of *Fleas*, by gradually going into Water, th a Lock of Wool in his Mouth, and ſo driving the *Fleas* into it, and then leaving it in the Water: By catching *ab*-Fiſh with his Tail, which he ſaith he himſelf was an e-witneſs of; *Vidi & ego in Scopulis Norvegiæ Vulpem, inter rupes miſſâ caudâ in aquas, plures educere Cancros, ac demum devorare.* . Mag. Hiſt. *l.* 18. *c.* 39, 40.

But *Pliny*'s fabulous Story of the *Hyæna* out-does theſe Re-ions of the *Fox*, *Sermonem humanum inter paſtorum ſtabula aſſi-lare, nomenque alicujus addiſcere, quem evocatum foràs laceret. Item mitionem hominis imitari ad ſollicitandos Canes quos invadat.* Plin. at. Hiſt. l. 8. c. 30.

(*kkk*) This do *Ducks*, *Woodcocks*, and many other Fowls, which ek their Food in dirty, mooriſh Places. For which Service ey have very remarkable Nerves reaching to the End of eir Bills. Of which ſee *Book* VII. *Chap.* 2. *Note* (*e*).

and delve for it, both above (*lll*), and under the Surface of the drier Lands (*mmm*)! And how curious and well designed a Provision is it of particular large Nerves in such Creatures, adapted to that especial Service!

What an admirable Faculty is that of many Animals, to discover their Prey at vast Distances; some by their Smell some Miles off (*nnn*); and some by their sharp and piercing Sight, aloft in the Air, or at other great Distances (*ooo*)! An Instance of the latter of which God himself gives [*Job* xxxix. 27, 28, 29.] in the Instinct of the *Eagle*: *Doth the Eagle mount up at thy Command, and make her Nest on high? She dwel-*
leth

(*lll*) *Swine*, and other Animals that dig, have their Nose made more tendinous, callous, and strong for this Service, than others that do not dig. They are also edged with a proper tough Border, for penetrating and lifting up the Earth; and their Nostrils are placed well, and their Smell is very accurate, to discover whatsoever they pursue by Digging.

(*mmm*) The *Mole*, as its Habitation is different from that of other Animals, so hath its Organs in every Respect curiously adapted to that way of Life; particularly its Nose made sharp, and slender, but withal tendinous and strong, &c. But what is very Remarkable, it hath such Nerves reaching to the End of its Nose and Lips, as *Ducks*, &c. have mentioned above in *Note* (*kkk*). Which Pair of Nerves I observed to be much larger in this Animal than any other Nerves proceeding out of its Brain.

(*nnn*) Predacious Creatures, as *Wolfs*, *Foxes*, &c. will discover Prey at great Distances; so will *Dogs* and *Ravens* discover Carrion a great Way off by their Smell. And if (as the Superstitious imagine) the latter flying over and haunting Houses be a Sign of Death, it is no doubt from some cadaverous Smell, those *Ravens* discover in the Air by their accurate Smell, which is emitted from those diseased Bodies, which have in them the Principles of a speedy Death.

(*ooo*] Thus *Hawks* and *Kites* on Land, and *Gulls*, and other Birds, that prey upon the Waters, can at a great Height

eth and abideth on the Rock, upon the Crag of he Rock, and the ſtrong Place (*ppp*). *From hence ſhe ſeeketh her Prey, and her Eyes behold far off.* What a commodious Proviſion hath the ontriver of Nature made for Animals, that are ceſſitated to climb for their Food; not only in e Structure of their Legs and Feet, and in the rength of their Tendons and Muſcles, acting in at particular Office (*qqq*); but alſo in the pecur Structure of the principal Parts, acting in the cqueſt of their Food (*rrr*)! What a Proviſion alſo

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Air ſee *Mice*, little Birds and Inſects on the Earth, and all Fiſhes, *Shrimps*, &c. in the Waters, which they will rt down upon, and take.

(*ppp*) Mr. *Ray* gives a good Account of the Nidification of *Chryſaëtos caudâ annulo albo cinctâ. Hujus Nidus Ann.* 1668. *ſylvoſis prope Derwentiam, &c. inventus eſt è bacillis ſeu virgis lig- grandioribus compoſitus, quorum altera extremitas rupis cujuſdam inentiæ, altera duabus Betulis innitebatur,——Erat Nidus quadra- duas ulnas latus. ——In eo pullus unicus, adjacentibus cadaveri- unius agni, unius leporis, & trium Grygallorum pullorum.* Synopſ. ethod. Avium, *p.* 6. And not only *Lambs*, *Hares*, and *Gry- i*, but Sir *Robert Sibbald* tells us, they will ſeize *Kids* and *wns*; yea, and Children too: Of which he hath this Story an *Eagle* in one of the *Orcades* Iſlands. *Quæ Infantulum unius ni pannis involutum arripuit* (*quem Mater teſſellas uſtibiles pro igne utura momento temporis depoſuerat in loco* Houton-Hed *dicto*) *eum- e deportâſſe per* 4 *milliaria paſſuum ad* Hoiam; *quâ re ex matris latibus cognita, quatuor viri illuc in navicula profecti ſunt, & ſcien- ubi Nidus eſſet, infantulum illæſum & intactum deprehenderunt.* od. Nat. Hiſt. Scot. *l.* 3. *part.* 2. *p.* 14.

(*qqq*) See in *Book* VII. *Chap.* 1. *Note* (*l*). the Characteriſticks of the *Woodpecker-kind.*

(*rrr*) *The Contrivance of the Legs, Feet, and Nails* [*of the* Opoſſum] *ſeems very advantagious to this Animal in climbing Trees* (*which doth very nimbly*) *for preying upon Birds.* But that is moſt ſingular in this Animal, is the Structure of its Tail, to enable to hang on Boughs. *The Spines, or Hooks ——in the middle of e under Side of the* Vertebræ *of the Tail, are a wonderful Piece of Nature's Mechaniſm. The firſt three* Vertebræ *had none of theſe*

alſo is that in nocturnal Birds and Beaſts, in the peculiar Structure of their Eye (*sss*), (and we may perhaps add the Accuracy of their Smell too) whereby they are enabled to diſcover their Food in the Dark? But among all the Inſtances we have of natural Inſtinct, thoſe Inſtincts, and eſpecial Proviſions made to ſupply the Neceſſities of Helpleſs Animals, do in a particular Manner demonſtrate the Great Creator's Care. Of which I ſhall give two Inſtances.

1. The Proviſion made for young Creatures. That Στοργὴ, that natural Affection, ſo connatural to all, or moſt Creatures towards their Young (*ttt*), what an admirable noble Principle is it, implant-

ed

Spines, but in all the reſt they were to be obſerved.——They were placed juſt at the Articulation of each Joynt, and in the Middle from the Sides.——For the performing this Office [of hanging by the Tail] *nothing, I think, could be more advantagiouſly contrived. For when the Tail is twirled or wound about a Stick, this Hook of the* Spinæ *caſily ſuſtains the Weight, and there is but little Labour of the Muſcles required, only enough for bowing or crooking the Tail.* This, and more to the ſame Purpoſe, ſee in Dr. *Tyſon*'s *Anatomy* of the *Opoſſum* in *Philoſophical Tranſact.* No. 239.

(*sss*) See before *Chap.* 2. *Note* (*z*), (*aa*), (*bb*).

(*ttt*) *Quid dicam quantus amor beſtiarum ſit in educandis cuſtodiendiſque iis, quæ procreaverint, uſque ad eum finem, dum poſſint ſeipſa defendere?* And having inſtanced in ſome Animals, where this Care is not neceſſary, and accordingly is not employed, he goes on, *Jam Gallinæ, aveſque reliquæ, & quietum requirunt ad pariendum locum, & cubilia ſibi, nidoſque conſtruunt, eoſque quàm poſſunt ſunt molliſſimè ſubſternunt, ut quàm facillimè ova ſerventur. Ex quibus pullos cùm excluſerint, ita tuentur, ut & pennis foveant, ne frigore lædantur, & ſi eſt calor, à ſole ſe opponant.* Cic. de Nat. Deor. 2. c. 51, 52.

To this natural Care of Parent-Animals to their young, we may add the Returns made by the young of ſome towards the old ones. *Pliny* ſaith of *Rats*, *Genitores ſuos feſſos ſenectâ, alunt inſigni pietate.* Nat. Hiſt. l. 8. c. 57. So *Cranes*, he ſaith, *Genitricum ſenectam invicem educant.* L. 10. c. 23.

This

d in them by the Wiſe Creator? By Means of hich, with what Alacrity do they tranſact their arental Miniſtry? With what Care do they nurſe o their Young; think no Pains too great to be ken for them, no Dangers (*uuu*) too great to be entured upon for their Guard and Security? low carefully will they lead them about in Pla-s of Safety, carry them into Places of Retreat nd Security; yea, ſome of them admit them into eir own Bowels (*www*)? How will they ca-reſs

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This St. *Ambroſe* takes Notice of in his *Hexameron*, and *Ol. agnus* after him, *Depoſiti patris artus, per longævum ſenectutis mis nudatos circumſtans ſoboles pennis propriis fovet, ——collatitio o paſcit, quando etiam ipſa naturæ reparat diſpendia, ut hinc inde ſe-m ſublevantes, fulcro alarum ſuarum ad volandum exerceant, & in iſtinos uſus deſueta membra reducant.* For which Reaſon this ird is denominated *Pia. Vid. Ol. Mag. Hiſt. l.* 19. *c.* 14.

Hereto may be added alſo the conjugal Στοργὴ of the little een *Æthiopian Parrot*, which Mr. *Ray* deſcribes from *Cluſius. emelleæ ſeneſcentes (quod valdè notabile) vix edere volebant, niſi cibum m à mare carptum, & aliquandiu in prolobo retentum, & quaſi coc-m roſtro ſuo exciperent, ut Columbarum pulli à matre ali ſolent.* ynopſ. Meth. Av. p. 32.

(*uuu*) The moſt timid Animals, that at other Times ab-ond, or haſtily fly from the Face of Man, Dogs, &c. will, r the ſake of their Young, expoſe themſelves. Thus among owls, *Hens* will aſſault, inſtead of fly from ſuch as meddle ith their Brood. So *Partridges*, before their Young can fly, ill drop frequently down, firſt at leſſer, and then at greater Diſtances, to dodge and draw off Dogs from purſuing their oung.

(*www*) The *Opoſſum* hath a curious Bag on purpoſe for the ecuring and carrying about her Young. There are belonging o this Bag two Bones (not to be met with in any other Skeleton) and four Pair of Muſcles, and ſome ſay the Teats ie therein alſo. Dr. *Tyſon*, *Anat.* of the *Opoſſ.* in *Phil. Tranſ.* No. 239. where he alſo, from *Oppian*, mentions the *Dog-Fiſh*, hat upon any Storm or Danger, receives the young Ones nto her Belly, which come out again when the Fright is over. So alſo the *Squatina* and *Glaucus*, the ſame Author

reſs them with their affectionate Notes, lull and quiet them with their tender parental Voice, put Food into their Mouths, ſuckle them, cheriſh and keep them warm, teach them to pick, and eat, and gather Food for themſelves; and, in a Word, perform the whole Part of ſo many Nurſes, deputed by the Sovereign Lord and Preſerver of the World, to help ſuch young and ſhiftleſs Creatures, till they are come to that Maturity, as to be able to ſhift for themſelves?

And as for other Animals (particularly Inſects, whoſe Sire is partly the Sun, and whoſe numerous Off-ſpring would be too great for their Parent-Animal's Care and Proviſion) theſe are ſo generated, as to need none of their Care, by Reaſon they arrive immediately to their Ἡλικία, their perfect, adult State, and are able to ſhift for themſelves. But yet, thus far their parental Inſtinct (equivalent to the moſt rational Care and Foreſight) doth extend, that the old Ones do not wildly drop their Eggs and Sperm any where, at all Adventures, but ſo cautiouſly repoſit it in ſuch commodious Places (ſome in the Waters, ſome on Fleſh, ſome on Plants, proper and agreeable to their Species (*xxx*); and ſome ſhut up agreeable Food in their Neſts, partly for Incubation, partly for Food (*yyy*), that their Young in their *Aurelia*, or *Nympha* State, may find ſufficient and agreeable Food to bring them up, till they arrive to their Maturity.

Thus far the Parental Inſtinct and Care.

Next

ſaith, have the ſame Care for their Young, but receive them into different Receptacles.

(*xxx*) See *Book* VIII. *Chap.* 6.

(*yyy*) See *Chap.* 13. *Note* ( ).

(*zzz*) There

Next we may obſerve no leſs in the young themſelves, eſpecially in thoſe of the irrational Animals. Foraſmuch as the Parent-Animal is not able to bear them about, to cloath them, and to handle them, as Man doth; how admirably hath the Creator contrived their State, that thoſe poor young Creatures can ſoon walk about, and with the little Helps of their Dam, ſhift for, and help themſelves? How naturally do they hunt for their Teat, ſuck, pick (*zzz*), and take in their proper Food?

But for the Young of Man, their Parents Reaſon, joined with natural Affection, being ſufficient to help, to nurſe, to feed, and to cloath them; therefore they are born helpleſs, and are more abſolutely, than other Creatures, caſt upon their Parents Care (*aaaa*). A manifeſt Act and Deſignation of the Divine Providence.

2. The other Inſtance I promiſed, is the Proviſion made for the Preſervation of ſuch Animals as are ſometimes deſtitute of Food, or in Danger of being ſo. The Winter is a very inconvenient, improper

(*zzz*) There is manifeſtly a Superintending Providence in this Caſe, that ſome Animals are able to ſuck as ſoon as ever they are born, and that they will naturally hunt for the Teat before they are quite gotten out of the Secundines, and parted from the Navel-String, as I have ſeen. But for *Chickens*, and other young Birds, they not being able immediately to pick till they are ſtronger, have a notable Proviſion made for ſuch a Time, by a part of the Yolk of the Egg being incloſed in their Belly, a little before their Excluſion or Hatching, which ſerves for their Nouriſhment, till they are grown ſtrong enough to pick up Meat. *Vid. Book* VII. *Chap.* 4. *Note* (*a*).

(*aaaa*) *Qui* [Infantes] *de ope noſtrâ ac de divinâ miſericordiâ plus merentur, qui in primo ſtatim nativitatis ſuæ ortu plorantes ac flentes, nil aliud faciunt quàm deprecantur.* Cypr. Ep. ad Fid.

proper Seaſon, to afford either Food or Exerciſe to Inſects, and many other Animals. When the flowry Fields are diveſted of their Gaiety; when the fertile Trees and Plants are ſtripp'd of their Fruits, and the Air, inſtead of being warmed with the cheriſhing Beams of the Sun, is chilled with rigid Froſt; What would become of ſuch Animals as are impatient of Cold? What Food could be found by ſuch as are ſubſiſted by the Summer-Fruits? But to obviate all this Evil, to ſtave off the Deſtruction and Extirpation of divers Species of Animals, the Infinitely Wiſe Preſerver of the World hath as wiſely ordered the Matter; that, in the firſt Place, ſuch as are impatient of Cold, ſhould have ſuch a ſpecial Structure of their Body, particularly of their Hearts, and Circulation of their Blood (*bbbb*), as during that Seaſon, not to ſuffer any waſte of their Body, and conſequently not to need any Recruits; but that they ſhould be able to live in a kind of ſleepy, middle State, in their Places of ſafe Retreat, until the warm Sun revives both them and their Food together.

The next Proviſion is for ſuch as can bear the Cold, but would want Food then; and that is in ſome by a long Patience of Hunger (*cccc*), in others by

(*bbbb*) I might name here ſome of the Species of Birds, the whole Tribe almoſt of Inſects, and ſome among other Tribes, that are able to ſubſiſt for many Mouths without Food, and ſome without Reſpiration too, or very little: But it may ſuffice to inſtance only in the *Land-Tortoiſe*, of the Structure of whoſe Heart and Lungs, See *Book* VI. *Chap.* 5. *Note* (*b*).

(*cccc*) *Inediam diutiſſimè tolerat Lupus, ut & alia omnia carnivora, licèt voraciſſima; magnâ utique naturæ providentiâ; quoniam eſca non ſemper in promptu eſt.* Ray's Synopſ. Quadr. p. 174.

To

y their notable Inſtinct in laying up Food before-and againſt the approaching Winter (*dddd.*) Of his many entertaining Examples may be given; articularly we may, at the proper Seaſon, obſerve ot only the little Treaſures and Holes well-ſtock-d with timely Proviſions, but large Fields (*eeee*) here

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To the long Abſtinence mentioned of Brute Animals, I ope the Reader will excuſe me, if I add one or two Inſtances extraordinary Abſtinence among Men. One *Martha Taylor*, rn in *Derbyſhire*, by a Blow on the Back fell into ſuch a roſtration of Appetite, that ſhe took little Suſtenance, but me Drops with a Feather, from *Chriſtmas* 1667, for thirteen lonths, and ſlept but little too all the Time. See Dr. *Samp-'s* Account thereof in *Ephem. Germ. T.* 3. *Obſ.* 173.

To this we may add the Caſe of *S. Chilton*, of *Tinsbury*, ar *Bath*, who in the Years 1693, 1696, and 1697, ſlept di-rs Weeks together. And although he would ſometimes, a very odd manner, take Suſtenance, yet would lie a long ime without any, or with very little, and all without any nſiderable Decay. See *Phil. Tranſ.* No. 304.

(*dddd*) They are admirable Inſtincts which the *Sieur de auplau* relates of his own Knowledge, of the little Animals lled *Bohaques* in *Ukraine*. *They made Burroughs like* Rabbets, d *in* October *ſhut themſelves up, and do not come out again till* pril.——*They ſpend all the Winter under Ground, eating what they id up in Summer.*——*Thoſe that are lazy among them, they lay on eir Backs, then lay a great handful of dry Herbage upon their Bodies,* c. *then others drag thoſe Drones to the Mouths of their Burroughs, and thoſe Creatures ſerve inſtead of Barrows,* &c. *I have often ſeen them actiſe this, and have had the Curioſity to obſerve them whole Days to-ther.*——*Their Holes are parted like Chambers; ſome ſerve for ore-Houſes, others for Burying-Places,* &c. *Their Government is thing inferior to that of* Bees, &c. *They never go abroad without ſting a Centinel upon ſome high Ground, to give notice to the others hilſt they are feeding. As ſoon as the Centinel ſees any Body, it ſtands on his Hind-Legs and whiſtles.* Beauplau's *Deſcription of* Ukraine, Vol. I. *of the* Collection of Voyages, &c.

A like Inſtance of the Northern *Galli Sylveſtres*, ſee in *Chap.* 3. *Note* (*g*).

As for the Scriptural Inſtance of the *Ant*, ſee hereafter *Book* VIII. *Chap.* 5. *Note* (*d*).

(*eeee*) I

here and there throughout beſpread with conſid-
rable Numbers of the Fruits of the neighbouring
Trees, laid carefully up in the Earth, and covered
ſafe, by the provident little Animals inhabiting
thereabouts. And not without Pleaſure have I ſeen
and admired the Sagacity of other Animals, hunt-
ing out thoſe ſubterraneous Fruits, and pillaging the
Treaſures of thoſe little provident Creatures.

And now from this bare tranſient View of this
Branch of the Great Creator's Providence and Go-
vernment, relating to the *Food* of his Creatures, we
can conclude no leſs, than that ſince this Grand
Affair hath ſuch manifeſt Strokes of admirable and
wiſe Management, that ſince this is demonſtrated
throughout all Ages and Places, that therefore it
is God's Handy-Work. For how is it poſſible that
ſo vaſt a World of Animals ſhould be ſupported,
ſuch a great Variety equally and well ſupplied with
proper Food, in every Place fit for Habitation,
without an eſpecial Superintendency and Manage-
ment, equal to, at leaſt, that of the moſt prudent
Steward and Houſholder? How ſhould the Crea-
tures be able to find out their Food when laid up
in ſecret Places? And how ſhould they be able to
gather even a great deal of the common Food, and

(eeee) I have in *Autumn*, not without Pleaſure obſerved
not only the great Sagacity and Diligence of *Swine*, in hunt-
ing out the Stores of the *Field Mice*; but the wonderful Pre-
caution alſo of thoſe little Animals, in hiding their Food be-
forehand againſt Winter. In the Time of Acorns falling, I
have, by means of the *Hogs*, diſcovered, that the *Mice* had
all over the neighbouring Fields, treaſured up ſingle Acorns
in little Holes they had ſcratched, and in which they had
carefully covered up the Acorn. Theſe the *Hogs* would, Day
after Day, hunt out by their Smell.

laſt to macerate and digeſt it, without peculiar rgans adapted to the Service? And what leſs than Infinitely Wiſe God could form ſuch a Set of rious Orgáns, as we find every Species endowed ith, for this very Uſe? Organs ſo artificially made, exquiſitely fitted up, that the more ſtrictly we rvey them, the more accurately we view them ven the meaneſt of them with our beſt Glaſſes) e leſs Fault we find in them, and the more we lmire them: Whereas the beſt poliſhed, and moſt quiſite Works, made by Human Art, appear thro' r Glaſſes, as rude and bungling, deformed and onſtrous; and yet we admire them, and call them Vorks of Art and Reaſon. And laſtly, What leſs an Rational and Wiſe could endow irrational nimals with various Inſtincts, equivalent, in their ecial Way, to Reaſon it ſelf? Inſomuch that ſome m thence have abſolutely concluded, that thoſe reatures had ſome Glimmerings of Reaſon. But is manifeſtly Inſtinct, not Reaſon they act by, ecauſe we find no varying, but that every Species th naturally purſue at all Times the ſame Methods nd Way, without any Tutorage or Learning: Whereas *Reaſon*, without Inſtruction, would often ary, and do that by many Methods, which *Inſtinct* th by one alone. But of this more hereafter.

CHAP. XII. *Of the Cloathing of Animals.*

HAving in the foregoing Chapter, ſomewhat largely taken a View of the Infinite Crea-r's Wiſdom and Goodneſs toward his Creatures, in

in ordering their Food, I ſhall be more brief in this Chapter, in my View of their *Cloathing* (*a*); another neceſſary Appendage of Life, and in which we have plain Tokens of the Creator's Art, manifeſted in theſe two Particulars; the *Suitableneſs of Animals Cloathing to their Place and Occaſions*; and the *Garniture and Beauty thereof.*

I. The Cloathing of Animals is ſuited to their Place of Abode, and Occaſions there; a manifeſt Act of Deſign and Skill. For if there was a Poſſibility, that Animals could have been accoutred any other Way, than by God that made them, it muſt needs have come to paſs, that their Cloathing would have been at all Adventures, or all made the ſame Mode and Way, or ſome of it, at leaſt, inconvenient and unſuitable. But on the contrary we find all is curious and compleat, nothing too much, nothing too little, nothing bungling, nothing but what will bear the Scrutiny of the moſt exquiſite Artiſt; yea, and ſo far out-do his beſt Skill that his moſt exquiſite Imitations, even of the meaneſt Hair, Feather, Scale, or Shell, will be found only as ſo many ugly, ill-made Blunders and Botches, when ſtrictly brought to the Teſt of good Glaſſes. But we ſhall find an Example remarkable enough in the preſent Caſe, if we only compare the beſt of Cloathing which Man makes for himſelf with that given by the Creator for the Covering

(*a*) Concerning the *Cloathing of* Animals, *Ariſtotle* obſerves, *That ſuch Animals have Hair as go on Feet, and are viviparous; that ſuch are covered with a Shell, as go on Feet, and are ovipar*. Hiſt. Anim. l. 3. c. 10.

(*b*) Co

e irrational Creatures. Of which it may be ſaid, our *Saviour* doth of the Flowers of the Field, *Matt.* vi. 29. *That even* Solomon, *in all his lory, was not arrayed like one of theſe.*

But let us come to Particulars, and conſider the itableneſs of the different Methods the Creator th taken in the Cloathing of Man, and of the ir-tional Animals. This *Pliny* (*b*) pathetically la-ents, and ſays, *It is hard to judge, whether lature hath been a kinder Parent, or more uel Step-Mother to Man. For,* ſays he, *Of l Creatures, he alone is covered with other's iches, whereas Nature hath given various loathing to other Animals, Shells, Hides, rickles, Shag, Briſtles, Hair, Down, Quills, ales, Fleeces; and Trees ſhe hath fenced with Bark or two againſt the Injuries of Cold and eat. Only poor naked Man,* ſays he, *is in the ay of his Birth caſt into the wide World, to im-*

(*b*) *Cujus* [Hominis] *causâ videtur cuncta alia genuiſſe Natura, gnâ & ſævâ mercede contra tanta ſua munera: ut non ſit ſatis æſti-re, Parens melior homini, an triſtior Noverca fuerit. Ante omnia um Animantium cunctorum alienis velat opibus: cæteris variè tegu-nta tribuit, teſtas, cortices, coria, ſpinas, villos, ſetas, pilos, plumam, nas, ſquamas, vellera. Truncos etiam arboreſque cortice, interdum mino, à frigoribus, & calore tutata eſt. Hominem tantùm nudum, in nudâ humo, natali die abjicit ad vagitus ſtatim & ploratum, llumque tot animalium aliud ad lacrymas, & has protinus vitæ ncipio.* Plin. Nat. Hiſt. l. 7. Procem.

Let *Seneca* anſwer this Complaint of *Pliny*, although per-ps what he ſaith might be more properly noted in another ace: *Quiſquis es iniquus æſtimator ſortis humanæ, cogita quanta bis tribuerit Parens noſter, quanto valentiora animalia ſub jugum iſerimus, quanto velociora aſſequamur, quam nihil ſit mortale non b ictu noſtro poſitum. Tot virtutes accepimus, tot artes, animum deni-e cui nihil non eodem quo intendit momento pervium eſt, Sideribus lociorem, &c.* Senec. de Benef. l. 2. c. 29.

(*c*) *Miran-*

immediate crying and ſqualling; and none of all Creatures beſides, ſo ſoon to Tears in the very beginning of their Life.

But here we have a manifeſt Demonſtration of the Care and Wiſdom of God towards his Creatures; that ſuch ſhould come into the World with their Bodies ready furniſhed and accommodated, who had neither Reaſon nor Forecaſt to contrive, nor Parts adapted to the Artifices and Workmanſhip of Cloathing; but for Man, he being endowed with the tranſcending Faculty of Reaſon, and thereby made able to help himſelf, by having Thoughts to contrive, and withal Hands to effect, and ſufficient Materials (*c*) afforded him from the Skin

(*c*) *Mirantur plurimi quomodo tutè, & ſanè vivant homines in horrendis frigoribus plagæ Sepentrionalis; hancque levem quæſtionem abſurdam 30 annos audieram in Italiâ, præſertim ab Æthiopibus, & Indis, quibus oneroſus videtur veſtitus ſub Zonâ torridâ.* ——*Quibus reſpondetur* ——*Gaudet Indus multiplici plumarum genere, magis forſan pro ornamento, quàm neceſſitate: rurſus Scytha villoſo veſtitu.* ——*Ita ſub Arctico adversùs aſperrimas hyemes* ——*opportuna remedia facilè adminiſtrat* [Natura,] *Ligna videlicet in maximâ copiâ, & leviſſimo pretio, & demum Pelles diverſorum animalium, tam ſylveſtrium quam domeſticorum.* Then he gives a Catalogue of them, and ſaith, *Quarum omnium experti pellifices ita ingeniosè noverunt mixturas componere, ut pulcherrimum decorem oſtendat varietas, & calidiſſimum ſit mentum adjuncta mollities.* Ol. Mag. Hiſt. l. 6. c. 20.

To this Guard againſt the Cold, namely, of Fire and Cloathing; I hope the Reader will excuſe me, if I take the Opportunity of adding ſome other Defenſatives Nature, (or rather the Great Author of Nature,) hath afforded theſe Northern Regions: Such are their high Mountains, abounding, as *Ol. Magnus* ſaith, through all Parts; alſo, their numerous Woods, which beſides their Fire, do, with the Mountains, ſerve as excellent Screens againſt the Cold, piercing Air, and Winds. Their prodigious Quantities of Minerals, and Metals alſo afford Heat, and warm Vapours, *Mineræ ſeptentrionalium regionum ſatis multæ, magnæ, diverſæ, & opulentæ ſunt,* ſaith the ſame curious, and (for his Time,) learned Archbiſhop

kins and Fleeces of Animals, and from various rees and Plants: Man, I ſay, having all this oviſion made for him, therefore the Creator th wiſely made him naked, and left him to ſhift

. 2. 1. and in other Places. And for the Warmth they af-d, the *Vulcano*'s of thoſe Parts are an Evidence; as are alſo eir terrible Thunder and Lightning, which are obſerv'd to the moſt ſevere and miſchievous in their metalline Moun-ns, in which large Herds of Cattle are ſometimes deſtroy'd: e Rocks ſo rent and ſhattered, that new Veins of Silver are ereby diſcover'd; and a troubleſome Kind of Quinſie is oduc'd in their Throats, by the Stench, and poiſonous Na-re of the ſulphureous Vapours, which they diſſolve, by inking warm Beer and Butter together, as *Olaus* tells us in e ſame Book, *Chap.* 11.

To all which Defenſatives, I ſhall, in the laſt Place add, e warm Vapours of their Lakes, (ſome of which are prodi-uſly large, of 130 *Italian* Miles in Length, and not much in Breadth;) alſo of their Rivers, eſpecially the Vapours ich ariſe from the Sea. Of which Guard againſt ſevere ld, we have lately had a convincing Proof in the *Great* ſt, in 1708, wherein, when *England*, *Germany*, *France*, *Den-rk*; yea, the more ſoutherly Regions of *Italy*, *Switzerland*, d other Parts, ſuffer'd ſeverely; *Ireland* and *Scotland* felt ry little of it, hardly more than in other Winters; of the rticulars of which, having given an Account in the *Philoſ. an.* No. 324. I ſhall thither refer the Reader. But it ems, this is what doth ordinarily befal thoſe Northern Parts; rticularly the *Iſlands* of *Orkney*, of which the learned Dr. *allace* gives this Account: *Here the Winters are generally more bject to Rain than Snow; nor doth the Froſt and Snow continue ſo g here, as in other Parts of* Scotland; *but the Wind in the mean me will often blow very boiſterouſly; and it Rains ſometimes, not by ops, but by Spouts of Water, as if whole Clouds fell down at once. In Year* 1680, *in the Month of* June, *after great Thunder, there fell kes of Ice near a Foot thick.* Wall. *Account of* Orkney, *ch.* 1. 4. From which laſt Paſſage I obſerve; That although in oſe Parts, the Atmoſphere near the Earth be warm, it is ceſſively Cold above; ſo as to freeze ſome of thoſe Spouts Water in their Deſcent, into ſuch great, and almoſt incre-ible Maſſes of Hail. And whence can this Warmth pro-ed, but from the Earth, or Sea, emitting Heat ſufficient to ave off the Cold above? Conſult *Book* II. *Chap.* 5. *Note* (c).

(d) *Sicut*

ſhift for himſelf, being ſo well able to help himſelf.

And a notable Act this is of the Wiſdom of GOD, not only as the more ſetting forth his Care and Kindneſs to them that moſt needed his Help, the helpleſs irrational Animals, and in his not over-doing his Work; but alſo as it is moſt agreeable to the Nature and State of Man (*d*), both on natural and political Accounts. That Man ſhould cloath himſelf, is moſt agreeable to his Nature, particularly (among other Things,) as being moſt ſalutary, and moſt ſuitable to his Affairs. For by this Means Man can adapt his Cloathing to all Seaſons, to all Climates, to this, or to any Buſineſs. He can hereby keep himſelf ſweet and clean, fence off many Injuries; but above all, by this Method of Cloathing with the natural Texture of his Skin adapted to it is that grand Means of Health, namely, *inſenſible Perſpiration* (*e*) is perform'd, at leaſt greatly promoted

(*d*) *Sicut enim ſi innata ſibi* [i. e. Homini] *aliqua haberet arma illa ei ſola ſemper adeſſent, ita & ſi artem aliquam Natura ſuppeditaſſet, reliquas ſanè non haberet. Quia verò ei melius erat omnibus armis, omnibuſque artibus uti, neutrum eorum à naturâ ipſi propterea datum eſt.* Galen. de Uſ. Part. l. 1. c. 4.

(*e*) Concerning *inſenſible Perſpiration*, *Sanctorius* obſerves, That it much exceeds all the Senſible put together. *De Stat. Med. Aph.* 4. That as much is evacuated by *inſenſible Perſpiration* in one Day, as is by *Stool* in fourteen Days. Particularly, That, in a Night's Time, about ſixteen Ounces is commonly ſent out by *Urine*, four Ounces by *Stool*; but above forty Ounces by *inſenſible Perſpiration*. Apor. 59, 60. That if a Man eats and drinks eight Pounds in a Day, five Pounds of it is ſpent in *inſenſible Perſpiration*, Sect. 1. Aph. 6. And as to the Times, he ſaith, *Ab aſſumpto cibo 5 horis 1 l. circiter perſpirabilis ——exhalare ſolet, à 5a ad 12am 3 l. circiter; à 12a ad 16am vix ſelibram.* Aph. 56.

And as to the wonderful Benefits of *inſenſible Perſpiration*, they are abundantly demonſtrated by the ſame learned Pe-

noted, without which an Human Body would be oon over-run with Diſeaſe.

In the next Place, there are good political Rea-n's for Man's cloathing himſelf, inaſmuch as his ıduſtry is hereby employed in the Exerciſes of his rt and Ingenuity; his Diligence and Care are erted in keeping himſelf, ſweet, cleanly, and neat; any Callings and Ways of Life ariſe from thence, d, (to name no more,) the Ranks and Degrees Men are hereby in ſome Meaſure rendered viſible others, in the ſeveral Nations of the Earth.

Thus it is manifeſtly beſt for Man that he ſhould oath himſelf.

But for the poor ſhiftleſs Irrationals, it is a odigious Act of the great Creator's Indulgence, at they are all ready furniſhed with ſuch Cloath-g, as is proper to their Place and Buſineſs (*f*). me covered with Hair (*g*), ſome with Feathers

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n, *ubi ſupra*; as alſo by *Borelli* in his ſecond Part, *De Mot. imal.* Prop. 168. who ſaith, *Neceſſaria eſt inſenſibilis Tranſpi-io, ut vita Animalis conſervetur.*

(*f*) *Animantium verò quanta varietas eſt? Quanta ad eam rem ut in ſuo quaque genere permaneant? Quarum alia coriis tecta t, alia villis veſtita, alia ſpinis hirſuta: plumâ alias, alias ſquamâ lemus obductas, alias eſſe cornibus armatas, alias habere effugia pen-rum.* Cic. de Nat. Deor. l. 2. c. 47.

(*g*) From *Malpighi*'s curious Obſervations of the *Hair*, I all note three Things. 1. Their Structure is fiſtulous, or ular; which hath long been a Doubt among the curious. *ſtuloſum* [eſſe Pilum] *demonſtrant luſtratio pilorum à cauda & Equorum, &c.——præcipuè ſetarum Apri, quæ patentiorem ex ulis compoſitionem exhibent. Eſt autem dictus Apripilus Cylindri-m corpus quaſi diaphanum——fiſtularum aggere conflatum, & ſpe-m columnæ ſtriatæ præ ſe fert. Componentes fiſtulæ in gyrum ſituatæ apice patentiores redduntur; nam hiant pilis in geminas dividitur rtes, & componentes minimæ fiſtulæ——liberiores redditæ manifeſ-tur, ita ut enumerati poſſunt; has autem 20, & ultra numeravi.*

thers (*h*), ſome with Scales, ſome with Shells (*i*), ſome only Skin, and ſome with firm and ſtout Armature; all nicely accommodated to the Element in which the Creature liveth, and its Occaſions there (*k*). To *Quadrupeds* Hair is a commodious Cloathing

——*Expoſitæ fiſtulæ*——*tubuloſæ ſunt, & frequentibus tunicis tranſverſaliter, ſituatis, veluti valvulis pollent. Et quoniam Spinæ Erinaceis præcipui, &c. nil aliud ſunt, quam duri & rigidi pili, &c.* And then he deſcribes the *Hedgehog*'s Spines, in which thoſe Tubes manifeſtly appear; together, with medullary Valves and Cells; not inelegant, which he hath figur'd in *Tab.* 16, at the End of his Works.

That which this ſagacious, and not enough to be commended Obſerver, took notice of in the Structure of Hair and its Parity to the Spines; I have my ſelf obſerv'd in ſome Meaſure to be true, in the Hair of *Cats*, *Rats*, *Mice*, and divers other Animals; which look very prettily when view'd with a good Microſcope. The Hair of a *Mouſe*, (the moſt tranſparent of any I have view'd,) ſeems to be one ſingle tranſparent Tube, with a Pith made up of a fibrous Subſtance, running in dark Lines; in ſome Hairs tranſverſly, in others ſpirally, as in *Fig.* 14, 15, 16, 17. Theſe darker medullary Parts, or Lines, I have obſerv'd, are no other than ſmall Fibres convolved round, and lying cloſer together than in other Parts of the Hair. They run from the Bottom, to the Top of the Hair; and I imagine, ſerve to the gentle Evacuation of ſome Humour out of the Body; perhaps, the Hair ſerves as well for the *inſenſible Perſpiration* of hairy Animals, as to fence againſt Cold and Wet. In *Fig.* 14, 16. I repreſented the Hair of a *Mouſe*, as it appears through a ſmall Magnifier; and in *Fig.* 15, 17: as it appears when view'd with a larger Magnifier.

Upon another Review, I imagine, That although in *Fig.* 14. 15. the dark Parts of the Pith ſeem to be tranſverſe; that they, as well as in the two other Figures, run round in a ſcrew-like Faſhion.

(*h*) See *Book* VII. *Chap.* 1. *Note* (*d*), (*e*).

(*i*) See *Chap.* 14. *Note* (*c*).

(*k*) It is a Sign ſome wiſe Artiſt was a Contriver of the Cloathing of Animals; not only as their Cloathing varies, to their Way of Living doth; but alſo becauſe every Part of their Bodies is furniſhed with proper ſuitable Cloathing.

The

ing; which, together with the apt Texture of their Skin, fitteth them for all Weathers, to lie on the Ground, and to do the Offices of Man; and the thick and warm Furs and Fleeces of others, are not only a good Defenſative againſt the Cold and Wet; but alſo a ſoft Bed to repoſe themſelves in; and to many of them, a comfortable covering, to nurſe and cheriſh their tender Young.

And as Hair to Quadrupeds; ſo Feathers are as commodious a Dreſs to ſuch as fly in the Air; to Birds, and ſome Inſects; not only a good Guard againſt Wet and Cold, and a comfortable Covering to ſuch as hatch and brood their Young; but alſo moſt commodious for their Flight. To which Purpoſe they are nicely and neatly placed every where on the Body, to give them an eaſy Paſſage through the Air (*l*), and to aſſiſt in the wafting their Body through that thin Medium. For which Service, how curious is their Texture for Lightneſs, and withal for Strength? Hollow and thin for Lightneſs, but withal, context and firm for Strength:

Thus divers Animals, that have their Bodies covered for the moſt Part with ſhort, ſmooth Hair, have ſome Parts left naked, where Hair would be an Annoyance: And ſome Parts beſet with long Hair; as their Mane and Tail: And ſome with ſtiff, ſtrong Briſtles; as about the Noſe: And ſometimes within the Noſtrils, to guard off, or give warning of Annoyances.

(*l*) The Feathers being placed from the Head towards the Tail, in cloſe and neat Order, and withal preened and dreſſed by the Contents of the Oil-Bag, afford as eaſy a Paſſage through the Air, as a Boat new cleaned and dreſſed finds in its Paſſage through the Waters. Whereas, were the Feathers placed the contrary, or any other Way (as they would have been, had they been placed by Chance, or without Art) they would then have gathered Air, and been a great Encumbrance to the Paſſage of the Body through the Air. See *Book* VII. *Chap.* 1. *Note* (*b*).

Strength. And where it is neceſſary they ſhould be filled, what a light and ſtrong, medullary Subſtance is it they are filled with? By which curious Contrivances, even the very heavieſt Parts made for Strength, are ſo far from being a Load to the Body, that they rather aſſiſt in making it light and buoyant, and capacitate it for Flight. But for the Vanes, the lighteſt Part of the Feather, how curiouſly are they wrought with capillary Filaments, neatly interwoven together (*m*), whereby they are not only light, but alſo ſufficiently cloſe and ſtrong, to keep the Body warm, and guard it againſt the Injuries of Weather, and withal, to impower the Wings, like ſo many Sails, to make ſtrong Impulſes upon the Air in their Flight (*n*). Thus curious, thus artificial, thus commodious is the Cloathing of Beaſts and Birds: Concerning which, more in proper Place.

And no leſs might I ſhew that of Reptiles and Fiſhes (*o*) to be, if it was convenient to enlarge upon this Branch of the Creator's Works. How well adapted are the *Annuli* of ſome Reptiles, and the Contortions of the Skin of others, not only to fence the Body ſufficiently againſt outward Injuries; but to enable them to creep, to perforate the Earth (*p*) and

(*m*) In *Book* VII. *Chap.* 1. *Note* (*e*), there is a particular Account of the Mechaniſm of their Vanes, from ſome nice Microſcopical Obſervations, and therefore I ſhall take no farther Notice of it here.

(*n*) *Vide Borell. de Mot. Animal.* Prop. 182. Vol. I.

(*o*) See *Book* IX.

(*p*) For a Sample of this Branch of my Survey, let us chuſe the Tegument of *Earth-Worms*, which we ſhall find compleatly adapted to their Way of Life and Motion, being made in the moſt compleat Manner poſſible for terebrating the Earth and

nd in a Word, to perform all the Offices of their Reptile State, much better than any other Tegument of the Body would do? And the ſame might be ſaid of the Covering of the Inhabitants of the Waters, particularly the Shells of ſome, which are ſtrong Guard to the tender Body that is within, nd conſiſtent enough with their ſlower Motion; nd the Scales and Skins of others, affording them n eaſy and ſwift Paſſage through the Waters. But may be ſufficient to give only a Hint of theſe Things, which more properly belong to another Place.

Thus hath the Indulgent Creator finiſhed the whole Animal World with convenient, ſuitable Cloathing.

II. Let us, in the next Place, take a ſhort View f the *Garniture* (*q*), and *Beauty* thereof. And ere we ſhall thus far, at leaſt, deſcry it to be eautiful; that it is Compleat and Workman-like.

Even

nd creeping where their Occaſions lead them. For their Boy is made throughout of ſmall Rings, and theſe Rings have curious *Apparatus* of Muſcles, enabling thoſe Creatures with reat Strength to dilate, extend, or contract their *Annuli*, and whole Body; thoſe *Annuli* alſo are each of them armed with mall, ſtiff, ſharp *Beards*, or *Prickles*, which they can open, o lay hold on, or ſhut up cloſe to their Body: And laſtly, Under the Skin there lies a *ſlimy Juice*, that they emit, as Occaſion is, at certain Perforations between the *Annuli*, to ubricate the Body, and facilitate their Paſſage into the Earth. By all which Means they are enabled with great Speed, Eaſe, nd Safety, to thruſt and wedge themſelves into the Earth; which they could not do, had their Bodies been covered with Hair, Feathers, Scales, or ſuch like Cloathing of the other Creatures. See more concerning this Animal, *Book* IX. *Chap.* 1. *Note* (*a*).

(*q*) *Ariſtotle*, in his *Hiſt. Anim. l.* 3. *c.* 12. names ſeveral Rivers, that by being drank of, change the Colour of the Hair.

Even the Cloathing of the moſt ſordid Animals, thoſe that are the leaſt beautified with Colours, or rather whoſe Cloathing may regrate the Eye (*r*); yet when we come ſtrictly to View them, and ſeriouſly conſider the nice Mechaniſm of one Part, the admirable Texture of another, and the exact Symmetry of the Whole; we diſcern ſuch Strokes of inimitable Skill, ſuch incomparable Curioſity, that we may ſay with *Solomon* Eccl. iii. 11. [GOD] *hath made every Thing beautiful in his Time.*

But for a farther Demonſtration, of the ſupereminent Dexterity of his Almighty Hand, he hath been pleaſed, as it were on Purpoſe, to give ſurprizing Beauties to divers Kinds of Animals. What radiant Colours are many of them, particularly ſome Birds and Inſects (*s*), bedeck'd with! What a prodigious Combination is there often of theſe, yea, how nice an Air frequently of meaner Colours (*t*), as to captivate the Eye of all Beholders, and exceed

(*r*) For an Example; Let us take the Cloathing of the *Tortoiſe* and *Viper*; becauſe, by an incurious View, it rather regrateth, than pleaſeth the Eye: But yet, by an accurate Survey, we find the Shells of the Former, and the Scales of the Latter, to be a curious Piece of Mechaniſm, neatly made; and ſo compleatly, and well put, and tacked together, as to exceed any Human Compoſures: Of the Latter, ſee more in *Book* IX. *Chap.* 1. *Note* (*c*).

(*s*) It would be Endleſs to enter into the Particulars of the beautiful *Birds* and *Inſects* of our *European* Parts; but eſpecially thoſe inhabiting the Countries between the Tropicks, which are obſerved as much to exceed our Birds in their Colours, as ours do theirs in their Singing.

(*t*) The *Wryneck*, at a Diſtance, is a Bird of mean Colour; neither are indeed its Colours radiant, or beautiful, ſingly conſider'd: But when it is in the Hand we ſee its light and darker Colours ſo curiouſly mixed together, as to give the Bird a ſurprizing Beauty. The ſame is alſo obſervable in many Inſects, particularly of the *Phalæna*-Kind.

the

the Dexterity of the moſt exquiſite Pencil to copy?

And now, when we thus find a whole World of Animals, cloathed in the wiſeſt Manner, the moſt ſuitable to the Element in which they live, the Place in which they reſide, and their State and Occaſions there; when thoſe that are able to ſhift for themſelves, are left to their own Diſcretion and Diligence, but the Helpleſs well accouter'd and provided for; when ſuch incomparable Strokes of Art and Workmanſhip appear in all, and ſuch inimitable Glories and Beauties in the Cloathing of others; who can, without the greateſt Obſtinacy and Prejudice, deny this to be GOD's Handy-work? The Gaudy, or even the meaneſt Apparel, which Man provideth for himſelf, we readily enough own to be the Contrivance, the Work of Man: And ſhall we deny the Cloathing of all the Animal World beſides (which infinitely ſurpaſſeth all the Robes of Earthly Majeſty; ſhall we, dare we, deny that) to be the Work of any Thing leſs than of an Infinite, Intelligent Being, whoſe Art and Power are equal to ſuch Glorious Work!

CHAP. XIII.

Of the Houſes and Habitations of Animals.

HAving in the laſt Chapter, as briefly, as well I could, ſurveyed the *Cloathing* of Animals, I ſhall in this take a View of their *Houſes*, *Neſts*, their *Cells* and *Habitations*; another Thing no leſs neceſſary to their Well-being than the laſt; and in which the Great Creator hath likewiſe ſignalized

his Care and Skill, by giving Animals an architectonick Faculty, to build themſelves convenient Places of Retirement, in which to repoſe and ſecure themſelves, and to nurſe up their Young.

And here, as before, we may conſider the Caſe of Man, and that of the irrational Animals. Man having (as I ſaid) the Gift of Reaſon and Underſtanding, is able to ſhift for himſelf, to contrive and build, as his Pleaſure leads him, and his Abilities will admit of. From the meaneſt Huts and Cottages, he can erect himſelf ſtately Buildings, bedeck them with exquiſite Arts of Architecture, Painting, and other Garniture; ennoble them, and render them delightful with pleaſant Gardens, Fountains, Avenues, and what not? For Man therefore the Creator hath abundantly provided in this Reſpect, by giving him an Ability to Help himſelf. And a wiſe Proviſion this is, inaſmuch as it is an excellent Exerciſe of the Wit, the Ingenuity, the Induſtry and Care of Man.

But ſince Ingenuity, without Materials, would be fruitleſs, the Materials therefore which the Creator hath provided the World with, for this very Service of Building, deſerves our Notice. The great Varieties of Trees (*a*), Earth, Stones, and Plants,

(*a*) ——*Dant utile lignum*
Navigiis Pinos, domibus Cedroſque, Cupreſſoſque:
Hinc radios trivere Rotis, hinc tympana plauſtris
Agricolæ, & pandas ratibus poſuere carinas.
Viminibus Salices fœcundæ, frondibus Ulmi;
At Myrtus validis haſtilibus, & bona bello
Cornus; Ityræos Taxi torquentur in arcus:
Nec Tiliæ leves, aut torno raſile Buxum,
Non formam accipiunt, ferroque cavantur acuto:
Necnon & torrentem undam levis innatat Alnus

Miſſa

lants, anſwering every Occaſion and Purpoſe of lan for this Uſe, in all Ages and Places all the Vorld over, is a great Act of the Creator's Good-eſs; as manifeſting, that ſince he has left Man to ift for himſelf, it ſhould not be without ſufficient elp to enable him to do ſo, if he would but make ſe of them, and the Senſe and Reaſon which God th given him.

Thus ſufficient Proviſion is made for the Habita-on of Man.

And no leſs ſhall we find is made for the reſt of e Creatures; who although they want the Power Reaſon to vary their Methods, and cannot add or diminiſh from, or any way make Improve-ents upon their natural Way; yet we find that tural Inſtinct, which the Creator's Infinite Un-rſtanding hath imprinted in them, to be abun-ntly ſufficient, nay, in all Probability, the very eſt or only Method they can take, or that can be vented for the reſpective Uſe and Purpoſe of each eculiar Species of Animals (*b*). If ſome Crea-res make their Neſts in Houſes, ſome in Trees, me in Shrubs, ſome in the Earth (*c*), ſome in Stone,

Miſſa Pado: necnon & apes examina condunt
Corticibuſque cavis, vitioſaque Ilicis alveo.
Virg. Georg. l. 2. carm. 442.

(*b*) See *Chap.* 15. and *Book* VIII. *Chap.* 6.

(*c*) Many of the *Veſpæ-Ichneumones* are remarkable enough their Nidification and Proviſion for their Young. Thoſe at build in Earth (who commonly have golden and black ings round their *Alvi*) having lined the little Cells, they ve perforated, lay therein their Eggs, and then carry into em Maggots from the Leaves of Trees, and ſeal them up ſe and neatly. And another *Ichneumon*, more of the *Veſpa* an *Muſca-Ichneumon* Kind (having a little Sting in its Tail, a black Colour) gave me the Pleaſure, one Summer, of ſeeing

Stone, ſome in the Waters, ſome here, and ſome there, or have none at all; yet we find, that that Place, that Method of Nidification doth abundantly anſwer the Creatures Uſe and Occaſions. They can there ſufficiently and well repoſe, and ſecure themſelves, lay, and breed up their Young. We are ſo far from diſcovering any Inconvenience in any of their reſpective Ways, from perceiving any Loſs befal the Species, any Decay, any Periſhing of their Young; that in all Probability, on the contrary, in that particular Way they better thrive, are more ſecure, and better able to ſhift for, and help themſelves. If, for Inſtance, ſome Beaſts make to themſelves no Habitation, but lie abroad in the open Air, and there produce their Young; in this Caſe we find there is no Need it ſhould be otherwiſe, by Reaſon they are either taken Care of by

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ſeeing it build its Neſt in a little Hole in my Study-Window. This Cell was coated about with an odoriferous, reſinous Gum, collected, I ſuppoſe, from ſome Fir-Trees near; after which it laid two Eggs (I think the Number was) and then carried in divers Maggots, ſome bigger than it ſelf. Then it very ſagaciouſly ſealed cloſe up into the Neſt, leaving them there doubtleſs, partly to aſſiſt the Incubation; and eſpecially for Food to the future Young when hatched.

Of this Artifice of theſe *Ichneumons*, *Ariſtotle* himſelf takes Notice, (but I believe he was ſcarce aware of the Eggs ſealed up with the Spiders.) Οἱ δ' Σφῆκες Ἰχνεύμονες καλούμενοι, &c. *As to the* Veſpæ, *called* Ichneumones, (*leſs than others*) *they* take Spiders, *and carry them into their Holes, and having ſealed them up with Dirt, they therein hatch, and produce thoſe of the ſame Kind.* Hiſt. Anim. l. 5. c. 20.

To what hath been ſaid about theſe *Ichneumon Waſps*, I ſhall add one Obſervation more, concerning the providential Structure of their Mouth in every of their Tribes, *viz.* their Jaws are not only very ſtrong, but nicely ſized, curved and placed for gnawing and ſcraping thoſe compleat little Holes they perforate in Earth, Wood, yea, in Stone it ſelf.

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an (*d*), or in no Danger, as other Creatures, om Abroad. If others repoſite their Young in oles (*e*) and Dens, and ſecure themſelves alſo erein, it is, becauſe ſuch Guard, ſuch Security is anting, their Lives being ſought either by the oſtility of Man, or to ſatisfy the Appetite of ra-cious Creatures (*f*). If among Birds, ſome build eir Neſts cloſe, ſome open, ſome with this, ſome ith another Material, ſome in Houſes, ſome in ees, ſome on the Ground (*g*), ſome on Rocks d Crags on high (of which GOD himſelf hath ven an Inſtance in the *Eagle*, Job xxxix. 27, 28.) nd ſo among the Inſect and Reptile Kinds, if ſome poſite their Eggs or Young in the Earth, ſome in Wood,

(*d*) *Tully* having ſpoken of the Care of ſome Animals to-rds their Young, by which they are nurſed and brought up, h, *Accedit etiam, ad nonnullorum animantium, & earum rerum s terra gignit, conſervationem, & ſalutem, hominum etiam ſolertia diligentia. Nam multæ & pecudes, & ſtirpes ſunt, quæ ſine pro-ione hominum ſalvæ eſſe non poſſunt.* Cic. de Nat. Deor. l. 2. 52.

(*e*) Prov. xxx. 26. *The Conies are but a feeble Folk, yet make their Houſes in the Rocks.*

(*f*) See *Note* (*l*).

(*g*) It is a notable Inſtinct which *Ol. Magnus* tells of the *li Sylveſtres*, in his Northern Country, to ſecure themſelves ainſt the Cold and Storms of the Winter. *Cùm nives inſtar ium terræ ſuperficiem ubique cooperiunt, ramoſque arborum diutiùs rimunt & condenſant, certos fructus Betulæ arboris——in formâ i Piperis vorant, & glutiunt indigeſtos; idque tantâ aviditate, ac antitate, ut repletum guttur toto corpore majus appareat. Deinde titis agminibus ſeſe inter medios nivium colles immergunt, præſertim Jan. Febr. Martio, quando nives ut turbines, typhones, vel tempeſ-es graviſſimæ è nubibus deſcendunt. Cùmque cooperta ſunt,——cer-bebdomadis cibo in gutture collecto, egeſto, & reſumpto vivunt Vena-um canibus non produntur.——Quod ſi præſentiunt nivem immi-e majorem, prædicto fructu, iterum devorato, aliud domicilium cap-t, in eoque manent uſque ad finem Marti, &c.* Ol. Mag. Hiſt. 19. c. 33.

(*h*) It

Wood, ſome in Stone, ſome on one Kind of Plant, ſome on another, ſome in warm and dry Places, ſome in the Water, and moiſt Places, and ſome in their own Bodies only, as ſhall be ſhewn in proper Place; in all theſe Caſes it is in all Probability, the beſt or only Method the Animal can take for the Hatching and Production of its Young, for their Supplies, Safety, or ſome other main Point of their Being or Well-being. This is manifeſt enough in many Caſes, and therefore probable in all. It is manifeſt that ſuch Animals, for Inſtance, as breed in the Waters (as not only Fiſh, but divers Inſects, and other Land-Animals do) that their Young cannot be hatched, fed, or nurſed up in any other Element. It is manifeſt alſo, That Inſects, which lay their Eggs on this, and that, and the other agreeable Tree, or Plant, or in Fleſh, *&c.* that it is by that Means their Young are fed and nurſed up. And it is little to be doubted alſo, but that theſe Matrixes may much conduce to the Maturation and Production of the Young. And ſo in all other the like Caſes of Nidification, of Heat or Cold, Wet or Dry, Expoſed or Open, in all Probability this is the beſt Method for the Animal's Good, moſt ſalutary and agreeable to its Nature, moſt for its Fecundity, and the Continuance and Increaſe of its Species; to which every Species of Animals is naturally prompt and inclined.

Thus admirable is the natural Sagacity and Inſtinct (*h*) of the irrational Animals in the Conve-

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(*h*) It is a very odd Story (which I rather mention for the Reader's Diverſion, than for its Truth) which Dr. *Lud. Beaufort* relates. *Vir fide dignus narravit mihi, quòd cùm ſem*

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ience and Method of their Habitations. And no ſs is it in the Fabrick of them. Their architecto- ck Skill, exerted in the Curioſity and Dexteri- of their Works, and exceeding the Skill of Man imitate; this, I ſay, deſerves as much or more dmiration and Praiſe, than that of the moſt ex- iſite Artiſt among Men. For with what inimita- e Art (*i*) do theſe poor untaught Creatures lay parcel of rude and ugly Sticks and Straws, Moſs nd Dirt together, and form them into commo- ous Neſts? With what Curioſity do they line em within, wind and place every Hair, Feather, Lock of Wool, to guard the tender Bodies of emſelves, and their Young, and to keep them arm? And with what Art and Craft do many them thatch over, and coat their Neſts with- t, to dodge and deceive the Eye of Spectators, well as to guard and fence againſt the Injuries of Veather (*k*)? With what prodigious Subtilty do ſome

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imi gratiâ, nidum aviculæ ligno obturâſſet; ſeque occultâſſet, cupi- s videndi, quid in tali occaſione præſtaret; illa cùm fruſtra ſapiùs ntâſſet roſtro illud auferre, casûs admodum impatiens, abiit, & poſt iquod temporis ſpatium reverſa eſt, roſtro gerens plantulam, quâ ob- ramento applicatâ paulò poſt, illud veluti telum eripuit tantâ vi, ut ſperſa impetu herbula, ac occaſionem ipſi, ab aviculâ ejus virtutem ſcendi, præripuerit. Coſmog. divina, Sect. 5. Chap. 1. Had e told us what the Plant was, we might have given better redit to this Story.

(*i*) Of the Subtilty of Birds in Nidification, ſee *Plin. Nat. iſt. l.* 10. *c.* 33.

(*k*) Among many Inſtances that might be given of this ubtilty of Birds, and other Creatures, that of the *long-tailed itmouſe* deſerves Obſervation, who with great Art builds her Neſt with Moſſes, Hair, and the Webs of Spiders, caſt out om them when they take their Flight: See *Book* VIII. *hap.* 4. *Note* (*e*), with which the other Materials are ſtrongly ed together. Having neatly built, and covered her Neſt with

ſome foreign Birds (*l*), not only plat and weave th fibrous Parts of Vegetables together, and curiouſl tunnel them, and commodiouſly Form them int Neſts, but alſo artificially ſuſpend them on t tender Twigs of Trees, to keep them out of t reach of rapacious Animals?

And ſo for *Inſects*, thoſe little, weak, thoſe te der Creatures; yet, what admirable Artiſts are the in thīs Buſineſs of Nidification! With what gre Diligence doth the little *Bee* gather its Com from various Trees (*m*) and Flowers, the *Wa* from ſolid (*n*) Timber! And with what prodig

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with theſe Materials without; ſhe thatcheth it on the To with the *Muſcus arboreus ramoſus*, or ſuch like broad, whit Moſs, to keep out Rain, and to dodge the Spectator's Ey and within ſhe lineth it with a great Number of ſoft Feather ſo many, that I confeſs I could not but admire how ſo ſma a Room could hold them, eſpecially that they could be lai ſo cloſe and handſomely together, to afford ſufficient Roo for a Bird with ſo long a Tail, and ſo numerous an Iſſue this Bird commonly hath, which Mr. *Ray* ſaith, (*Synopſ. Me thod. Avium*, p. 74.) *Ova inter omnes aviculas numeroſiſſima pon* See more of the Neſt of this Bird, from *Aldrovand.* in *Willug Ornith.* p. 243.

(*l*) The Neſt of the *Guira tangeima*, the *Icterus minor*, an the *Jupujuba*, or whatever other Name the *American Hang Neſts* may be called by, are of this Kind. Of which ſee *Wi lugbby's Ornith. Lib.* 2. *Chap.* 5. *Sect.* 12, 13. Alſo Dr. *Grew Muſeum Reg. Soc. Part* 1. *Sect.* 4. *Chap.* 4. Theſe Neſts I hav divers Times ſeen, particularly in great Perfection in our R Repoſitory, and in the noble and well-furniſhed *Muſeum* my often-commended Friend Sir *Hans Sloane*; and at the ſam Time I could not but admire at the neat Mechaniſm of the and the Sagacity of the Bird, in hanging them on the Twi of Trees, to ſecure their Eggs and Young from the *Apes*.

(*m*) I mention Trees, becauſe I have ſeen *Bees* gather t Gum of Fir-Trees, which at the ſame Time gave me t Pleaſure of ſeeing their Way of loading their Thighs ther with; performed with great Art and Dexterity.

(*n*) *Waſps*, at their firſt Coming, may be obſerv'd to fr

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us geometrical Subtilty do thoſe little Animals ork their deep hexagonal Cells, the only proper igure that the beſt Mathematician could chuſe for ch a Combination of Houſes (*o*)! With what ccuracy do other Inſects perforate the Earth (*p*), Vood, yea, Stone it ſelf (*q*)! For which Service, e compleat Apparatus of their Mouths (*r*), and eet (*s*), deſerves particular Obſervation, as hath been

uent Poſts, Boards, and other Wood that is dry and ſound; t never any that is rotten. Theſe they may be heard to rape and gnaw; and what they ſo gnaw off, they heap cloſe gether between their Chin and Fore-Legs, until they have tten enough for a Burden, which they then carry away in eir Mouths, to make their Cells with.

(*o*) Circular Cells would have been the moſt capacious; t this would by no Means have been a convenient Figure, Reaſon much of the Room would have been taken up by acancies between the Circles; therefore, it was neceſſary to ake Uſe of ſome of the rectilinear Figures. Among which ly three could be of Uſe; of which *Pappus Alexandrin.* thus ſcourſeth: *Cùm igitur tres figuræ ſunt, quæ per ſeipſas locum circa m punctum conſiſtentem replere poſſunt, Triangulum ſcil. Quadratum Hexagonum, Apes illam quæ ex pluribus angulis conſtat ſapienter de-gerunt, utpote ſuſpicantes eam plus mellis capere quàm utram vis re-quarum. At Apes quidem illud tantùm quod ipſis utile eſt cognoſcunt, z. Hexagonum Quadrato & Triangulo eſſe majus & plus Mellis pere poſſe nimirum æquali materiâ in conſtructionem uniuſcujuſque nſumpta. Nos verò qui plus ſapientiæ quàm Apes habere profitemur, liquid etiam magis inſigne inveſtigabimus.* Collect. Math. l. 5.

(*p*) See before *Note* (*c*).

(*q*) See *Chap.* II. *Note* (*x*).

(*r*) See *Chap.* II. *Note* (*y*).

(*s*) Among many Examples, the Legs and Feet of the *Mole-Cricket*, (*Gryllotalpa*,) are very remarkable. The Fore-Legs are very brawny and ſtrong; and the Feet armed each ith four flat ſtrong Claws, together with a ſmall Lamina, ith two larger Claws, and a third with two little Claws: Which Lamina is joynted to the Bottom of the Foot, to be xtended, to make the Foot wider, or withdrawn within the oot. Theſe Feet are placed to ſcratch ſomewhat Sideways, s well as downward, after the Manner of *Moles* Feet; and ney are very like them alſo in Figure. Some-

been, and will be hereafter obſerv'd. And further yet; With what Care and Neatneſs do moſt of thoſe little ſagacious Animals line thoſe their Houſes within, and ſeal them up, and fence them without (*t*)! How artificially will others fold up the Leaves of Trees and Plants (*u*); others houſe themſelves in Sticks and Straws; others glue light and floating Bodies together (*w*), and by that Artifice make themſelves floating Houſes in the Waters,

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Somewhat of this Nature, *Swammerdam* obſerves of the Worms of the *Ephemeron*. *To this Purpoſe*, [to dig their Cells] *the Wiſe Creator hath furniſh'd them*, (ſaith he) *with fit Members. For, beſides that their two Fore-legs are formed ſomewhat like thoſe of the ordinary* Moles, *or* Gryllotalpa; *he hath alſo furniſh'd them with two toothy Cheeks, ſomewhat like the Sheers of* Lobſters, *which ſerve them more readily to bore the Clay.* Swammerdam's Ephem. Vit. Publiſh'd by Dr. *Tyſon*, Chap. 3.

(*t*) See the before-cited *Note* (*c*).

(*u*) They are for the moſt Part, ſome of the *Phalæna* Tribe, which inhabit the tunnalled, convolved Leaves, that we meet with on Vegetables in the Spring and Summer. And it is a ſomewhat wonderful Artifice, how ſo ſmall and weak a Creature, as one of thoſe newly-hatch'd Maggots, (for doubtleſs it is they, not the Parent-Animal, becauſe ſhe emits no Web, nor hath any tectrine Art,) can be able to convolve the ſtubborn Leaf, and then bind it in that neat round Form with the Thread or Web it weaves from its own Body; with which it commonly lines the convolved Leaf, and ſtops up the two Ends, to prevent its own falling out; and *Earwigs*, and other noxious Animals getting in.

(*w*) The ſeveral Sorts of *Phryganea*, or *Cadews*, in their *Nympha*, or *Maggot-ſtate*, thus houſe themſelves; one Sort in Straws, call'd from thence *Straw-Worms*; others in two or more Sticks, laid parallel to one another, creeping at the Bottom of Brooks; others with a ſmall Bundle of Pieces of Ruſhes, Duck-weed, Sticks, *&c.* glu'd together, wherewith they float on the Top, and can row themſelves therein about the Waters, with the Help of their Feet: Both theſe are call'd *Cob-bait*. Divers other Sorts there are, which the Reader may ſee a Summary of, from Mr. *Willughby*, in *Raii Method. Inſect. p.* 12. together with a good, though very brief Deſcrip-

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rs, to tranſport themſelves at Pleaſure after their ood, or other neceſſary Occaſions of Life! And r a Cloſe, let us take the ſcriptural Inſtance of e *Spider*, *Prov.* xxx. 28. which is one of the four tle Things, which, *v.* 24. *Agur* ſays, is *exceeding iſe: The Spider taketh hold with her Hands, d is in Kings Palaces* (*x*). I will not diſpute e Truth of our *Engliſh* Tranſlation of this Text, t ſuppoſing the Animal mention'd to be that hich is meant; it is manifeſt, that the Art of that ecies of Creatures, in ſpinning their various Webs, d the Furniture their Bodies afford to that Pur- ſe, are an excellent Inſtinct, and Proviſion of ature, ſetting forth its Glorious Author.

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n of the *Papilionaceous* Fly, that comes from the *Codbait Ca-*. It is a notable architectonick Faculty, which all the riety of theſe Animals have, to gather ſuch Bodies as are eſt for their Purpoſe, and then to glue them together; ſome be heavier than Water, that the Animal may remain at the ttom, where its Food is; (for which Purpoſe they uſe ones, together with Sticks, Ruſhes, &c.) and ſome to be hter than Water, to float on the Top, and gather its Food m thence. Theſe little Houſes look coarſe, and ſhew no eat Artifice outwardly; but are well tunnelled, and made thin with a hard tough Paſte; into which the hinder Part the Maggot is ſo fix'd, that it can draw its Cell after it y where, without Danger of leaving it behind; as alſo ruſt its Body out, to reach what it wanteth; or withdraw into its Cell, to guard it againſt Harms.

(*x*) Having mention'd the *Spider*, I ſhall take this Occaſion, lthough it be out of the Way) to give an Inſtance of the iſon of ſome of them. *Scaliger*, *Exerc.* 186. relates, *That in* aſcony, *his Country*, *there are* Spiders *of that virulency*, *that if a an treads upon them*, *to cruſh them*, *their Poiſon will paſs through e very Soles of his Shoe.* Boyl. Subtil. of Effluv. c. 4.

Mr. *Leewenhoek* put a *Frog* and a *Spider* together into a Glaſs, nd having made the *Spider* ſting the *Frog* divers Times, the og dy'd in about an Hour's Time. *Phil. Tranſ.* No. 272.

And now from this ſhort and tranſient View of the architectonick Faculty of Animals, eſpecially the Irrationals; we may eaſily perceive ſome Superiour and Wiſe Being was certainly concern'd in their Creation or Original. For, how is it poſſible that an irrational Creature ſhould, with ordinary and coarſe, or indeed any Materials, be ever able to perform ſuch Works, as exceed even the Imi-

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In the ſame *Tranſaction*, is a curious Account of the Manner how *Spiders* lay, and guard their Eggs, *viz.* they emit them not out of the hindermoſt Part of the Body, but under the upper Part of her Belly, near the Hind Legs, *&c.* Alſo there is an Account of the Parts from which they emit their Webs, and divers other Things worth Obſervation, with Cuts illuſtrating the Whole.

But in *Phil. Tranſ.* No. 22. Dr. *Nath. Fairfax*, from *S. Redi*, and his own Obſervations, thinks *Spiders* not venemous; ſeveral Perſons, as well as Birds, ſwallowing them without Hurt: Which I my ſelf have known in a Perſon of Learning, who was adviſ'd to take them medicinally at firſt, and would at any Time ſwallow them, affirming them to be ſweet, and well taſted: And not only innocuous, but they are very ſalutiferous too, in ſome of the moſt ſtubborn Diſeaſes, if the pleaſant Story in *Mouffet* be true; of a rich *London* Matron, cured of a deſperate *Tympany*, by a certain Debauchee, that hearing of her Caſe, and that ſhe was given over by the Doctors, went to her, pretending to be a Phyſician, and confidently affirming he would Cure her; which ſhe being willing to believe, agrees with him for ſo much Money, one half to be paid down, the other upon Cure. Upon which he gives her a *Spider*, promiſing her Cure in three Days. Upon which, (not doubting but that he had poiſon'd her, and fearing he might be call'd to Account for it,) he gets out of Town as faſt as he could. But inſtead of being poiſon'd, ſhe ſoon recover'd. After ſome Months, the Quack gets privately to Town, when he thought the Buſtle might be over; and enquiring how his Patient did, was inform'd of her Cure; and thereupon viſiting her, and making an Excuſe for his Abſence, he received his Pay with great Applauſe and Thanks. *Mouff. Inſect. l.* 2. *c*, 15.

Having ſaid ſo much of *Spiders*, I might here add their Flight: But of this, ſee *Book* VIII. *Chap.* 4. *Note* (*e*).

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ation of a rational Creature? How could the Bodies of many of them, (particularly the laſt mention'd) be furniſh'd with architective Materials? How could they ever diſcover them to be in their Bodies, or know what Uſe to make of them? We muſt therefore neceſſarily conclude, That the Irrationals either have Reaſon and Judgment, not only Glimmerings thereof, but ſome of its Superiour Acts, as Wiſdom and Foreſight, Diſcretion, Art and Care; or elſe, that they are only paſſive in the Caſe, and act by Inſtinct, or by the Reaſon of ome Superiour Being imprinted in their Nature, or ome Way or other, [be it how it will,] congenial with them. That they are Rational, or excel Man in Art and Wiſdom, none ſurely will be ſo oliſh as to ſay: And therefore we muſt conclude, That thoſe excellent Ends they purſue, and that admirable Art they exert, is none of their own, but owing to that Infinitely Wiſe and Excellent Being, of whom it may be ſaid, with Reference to the irrational, as well as rational Creatures, as it s, *Prov.* ii. 6. *The Lord giveth Wiſdom; out of his Mouth cometh Knowledge and Underſtanding.*

CHAP. XIV.

Of Animals Self-Preſervation.

HAving thus conſidered the Food, Cloathing, and Houſes of Animals; let us in this Chapter take a Glance of another excellent Proviſion, the Wiſe Creator hath made for the Good of the

animal World; and that is, the Methods which all Animals naturally take for their *Self-Preservation* and *Safety*. And here it is remarkable, (as in the Cases before,) that *Man*, who is endow'd with Reason, is born without Armature, and is destitute of many Powers, which irrational Creatures have in a much higher Degree than he, by Reason he can make himself Arms to defend himself, can contrive Methods for his own Guard and Safety, can many Ways annoy his Enemy, and stave off the Harms of noxious Creatures.

But for others, who are destitute of this Supereminent Faculty; they are some Way or other provided with sufficient Guard (*a*), proportionate to their Place of Abode, the Dangers they are like to incur there (*b*); and in a Word, to their greatest Occa-

(*a*) *Callent in hoc cuncta animalia, sciuntque non sua modò commoda, verùm & hostium adversa; nôrunt sua tela, nôrunt occasiones, partesque dissidentium imbelles. In ventre mollis est tenuisque cutis Concodilo: ideoque se, ut territi, mergent Delphini, subeunteque alvum illa secant spinâ.* Plin. Nat. Hist. l. 8. c. 25.

(*b*) *Omnibus aptum est Corpus Animæ moribus & facultatibus. Equo fortibus ungulis & jubâ est ornatum (etenim velox & superbum & generosum est animal.) Leoni autem, utpote animoso & ferocidentibus & unguibus validum. Ita autem & Tauro & Apro; illi enim Cornua, huic exerti Dentes.——Cervo autem & Lepori (timidi enim sunt animalia) velox corpus, sed inerme. Timidis enim velocitas, arma audacibus conveniebant ——Homini autem (sapiens enim est——) manus dedit, instrumentum ad omnes artes necessarium, potens non minùs quàm bello idoneum. Non igitur indiguit Cornu sibi innatum meliora Cornibus arma manibus, quandocunque volet, possit accipere: Etenim Ensis & Hasta majora sunt Arma, & ad incidendum promptiora ——Neque Cornu, neque Ungulæ quicquam nisi comiùs agere possunt; Hominum verò arma eminûs juxtà ac comiùs agunt. telum quidem & sagitta magis quàm cornua. ——Non igitur est mucidus, neque inermis. ——sed ipsi est Thorax ferreus, quandocunque libet omnibus Coriis difficilius fauciatu organum. ——Nec Thorax solùm sed & Domus, & Murus, & Turris, &c.* Galen. de Us. Part. l. 1. c. 2.

(*c*) She

Occaſions, and Need of Security. Accordingly, ſome are ſufficiently guarded againſt all common Dangers, by their natural Cloathing, by their Armature of Shells, or ſuch like hard, and impregnable Covering of their Body (*c*). Others deſtitute of this Guard, are armed, ſome with Horns (*d*), ſome with ſharp Quills and Prickles (*e*), ſome with Claws, ſome with Stings (*f*); ſome can ſhift and change

(*c*) Shells deſerve a Place in this Survey, upon the Account of their great Variety; the curious and uncouth Make of ſome, and the beautiful Colours, and pretty Ornaments of others; but it would be Endleſs to deſcend to Particulars. Omitting others, I ſhall therefore only take Notice of the *Tortoiſe-ſhell*, by Reaſon a great deal of Dexterity appears, even in the Simplicity of that Animal's Skeleton. For, beſides that the Shell is a ſtout Guard to the Body, and affords a ſafe Retreat to the Head, Legs and Tail, which it withdraws within the Shell upon any Danger; beſides this, I ſay, the Shell ſupplieth the Place of all the Bones in the Body, except thoſe of the extreme Parts, the Head and Neck, and the four Legs and Tail. So that at firſt Sight, it is ſomewhat ſurprizing to ſee a compleat Skeleton conſiſting of ſo ſmall a Number of Bones, and they abundantly ſufficient for the Creature's Uſe.

(*d*) *Dente timentur Apri: defendunt cornua Tauros:*
Imbelles Damæ quid niſi præda ſumus?
Martial. l. 13. Epigr. 94.

(*e*) The *Hedghog* being an helpleſs, ſlow, and patient Animal, is accordingly guarded with Prickles, and a Power of rolling it ſelf up in them. *Clavis terebrari ſibi pedes, & diſcindi viſcera patientiſſimè ferebat, omnes cultri ictus ſine gemitu pluſquam Spartanâ nobilitate concoquens.* Borrichius in Blaſ. de Echino. *Panniculum carnoſum amplexabatur Muſculus pænè circularis, admirandæ fabricæ, lacinias ſuas ad pedes, caudam, caput, variè exporrigens, cujus miniſterio Echinus ſe ad arbitrium in orbem contrahit.* Act. Dan. in Blaſio.

Iſte licèt digitos teſtudine pungat acutâ,
Cortice depoſito mollis Echinus erit. Mart. l. 13. Epig. 86.

(*f*) The *Sting* of a *Waſp*, or *Bee*, &c. is ſo pretty a Piece of Work, that it is worth taking Notice of, ſo far as I have not found others to have ſpoken of it. Others have obſerv'd

change their Colours (*g*); ſome can make their Eſcape by the Help of their Wings, and others by the

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the Sting to be an hollow Tube, with a Bag of ſharp penetrating Juices, (its Poiſon,) joined to the End of it, within the Body of the *Waſp*, which is, in Stinging, injected into the Fleſh through the Tube. But there are beſides this, two ſmall, ſharp, bearded Spears, lying within this Tube or Sting, as in a Sheath. In a *Waſp's* Sting, I counted eight Beards on the Side of each Spear, ſomewhat like the Beards of Fiſh-hooks. Theſe Spears in the Sting, or Sheath, lie one with its Point a little before that of the other; as is repreſented in *Fig.* 21, to be ready (I conceive,) to be firſt darted into the Fleſh; which being once fix'd, by Means of its foremoſt Beard, the other then ſtrikes in too, and ſo they alternately pierce deeper and deeper, their Beards taking more and more hold in the Fleſh; after which the Sheath or Sting follows, to convey the Poiſon into the Wound. Which, that it may pierce the better, it is drawn into a Point, with a ſmall Slit a little below that Point, for the two Spears to come out at. By Means of this pretty Mechaniſm in the Sting, it is, that the Sting when out of the Body, and parted from it, is able to pierce and ſting us: And by Means of the Beards being lodged deep in the Fleſh, it comes to paſs that *Bees* leave their Stings behind them, when they are diſturbed before they have Time to withdraw their Spears into their Scabbard. In *Fig.* 21, is repreſented the two Spears as they lie in the Sting. In *Fig.* 22, the two Spears are repreſented when ſqueez'd out of the Sting, or the Scabbard; in which Latter, *Fig. A c b*, is the Sting, *c d*, and *b e*, the two bearded Spears thruſt out.

(*g*) The *Camelion* is ſufficiently fam'd on this Account. Beſides which, *Pliny* tells us of a Beaſt as big as an *Ox*, called the *Tarandus*, that when he pleaſeth, aſſumes the Colour of an *Aſs*, and *Colorem omnium fruticum, arborum, florum, locorumque reddit, in quibus latet metuens, ideoque raro capitur.* Plin. l. 8. c. 34.

How true this is, there may be ſome Reaſon to Doubt; but if any Truth be in the Story, it may be from the Animal's chuſing ſuch Company, or Places, as are agreeable to its Colour: As I have ſeen in divers *Caterpillars*, and other Inſects, who I believe were not able to change their Colour from one Colour to another; yet I have conſtantly obſerv'd, do fix themſelves to ſuch Things as are of the ſame Colour; by which Means they dodge the Spectator's Eye. Thus the

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the Swiftneſs of their Feet; ſome can ſcreen themſelves by diving in the Waters, others by tinging and diſordering the Waters (*h*), can make their Eſcape; and ſome can guard their Bodies, even in the very Flames, by the Ejection of the Juice of their Bodies (*i*); and ſome by their accurate Smell, Sight, or Hearing, can foreſee Dangers (*k*); others by their natural Craft, can prevent or eſcape them (*l*); others by their Uncouth Noiſe (*m*);

Caterpillar that feeds on *Elder*, I have more than once ſeen, ſo cunningly adhering to the ſmall Branches of the ſame Colour, that it might be eaſily miſtaken for a ſmall Stick, even by a careful View. So a large green *Caterpillar*, that feeds on *Buckthorn*, and divers others. To which I may add the prodigious Sagacity of the *Ichneumon Flies*, that make the *Kermes*, (for of that Tribe all the *Kermes* I ever ſaw was;) how artificially they not only incloſe their Eggs within that gummy Skin, or Shell; but alſo ſo well humour the Colour of the Wood they adhere to, by various Streaks and Colours, that it is not eaſy to diſtinguiſh them from the Wood it ſelf.

(*b*) *Contra metum & vim, ſuis ſe armis quæque defendit. Cornibus Tauri, Apri dentibus, morſu Leones, aliæ fugâ ſe, aliæ occultatione tuantur: atramenti effuſione Sepiæ, torpore Torpedines. Multæ etiam inſectantes odoris intolerabili fœditate depellunt.* Cic. de Nat. Deor. l. 2. c. 50.

(*i*) A Knight, call'd *Corvini*, at *Rome*, caſt a *Salamander* into the Fire, which preſently ſwell'd, and then vomited Store of thick ſlimy Matter, which put out the Coals; to which the *Salamander* preſently retir'd, putting them out again in the ſame Manner, as ſoon as they re-kindled, and by this Means ſav'd it ſelf from the Force of the Fire for the Space of two Hours: After which it liv'd nine Months. *Vid. Philoſ. Tranſ.* No. 21. in *Lowth. Abridg. Vol.* 2. *p.* 816.

(*k*) *Pliny* gives an Inſtance in each. *L.* 10. *C.* 69. *Aquilæ clarius cernunt* [quàm homines;] *Vultures ſagaciùs odorantur: liquidiùs audiunt Talpæ obrutæ terrâ, tam denſo atque ſurdo naturæ elemento.*

(*l*) The *Doublings* of the *Hare*, before ſhe goes to Form, thereby to dodge and deceive the *Dogs*, although a vulgar

(*m*); by the horrid Aſpect, and ugly Geſticulations of their Body (*n*); and ſome even by the Power of their Excrements, and their Stink (*o*), can annoy their Enemy, and ſecure themſelves: and againſt ſome (*p*), the Divine Providence it ſelf hath provided a Guard. By

Obſervation, is a notable Inſtinct for an Animal, leſs fam'd for Cunning than the *Fox*, and ſome others.

(*m*) It is natural for many Quadrupeds, Birds and Serpents, not only to put on a torvous angry Aſpect, when in Danger; but alſo to ſnarl, hiſs, or by ſome other Noiſe deter their Adverſary.

(*n*) The *Iynx*, *or Wryneck*, although a Bird of very beautiful Feathers, and conſequently far enough off from being any way terrible; yet being in Danger, hath ſuch odd Contortions of its Neck, and Motions of its Head, that I remember have ſcar'd me, when I was a Boy, from taking their Neſts, or touching the Bird; daring no more to venture my Hand into their Holes, than if a Serpent had lodged in it.

(*o*) *Bonaſus tuetur ſe calcibus & ſtercore, quòd ab ſe quaternis paſſibus* [trium jugerum longitudine. *Plin. Nat. Hiſt. l.* 8. *c.* 15.] *ejaculatur, quod ſæpe combùrit adeò ut deglabrentur canes.* Ray's Synopſ. Quadr. p. 71.

Camelus Peruvianus Clama dictus neminem offendit, ſed miro admodum ingenio ſe ab illatâ vindicat injuriâ, nimirum vomitu vel cibi, vel humoris in vexantem retrorſum cum impetu ejaculato, ob protenſam colli longitudinem. Id. ib. p. 146.

Tzquiepatl (Anglicè *Squnck* Præf. and one that I ſaw they call'd a *Stonck*,) *Cùm quis eam inſectatur, fundit cum ventris crepitu halitum fœtidiſſimum: quin ipſa tota teterrimum exhalat odorem, & urina ſtercuſque eſt fœtidiſſimum, atque adeò peſtilens, ut nihil ſit reperire in noſtro orbe, cui in hâc re poſſit comparari: quo fit, ut in periculo conſtituta, urinam & fæces ad* 8 *pluriumve paſſuum intervallum ejiciat, hoc modo ſe ab omnibus vindicans injuriis, ac veſtes inficiens maculis luteis indelebilibus, & nunquam ſatis perſpirante odore: aliâs innoxium Animal eduleque, hâc ſolâ ratione horrendiſſimum.* Id. ib. p. 182.

Si Accipiter Ardeam in ſublimi moleſtat, ſtercore immiſſo in pennas ejus, eas putreſcere facit: uti Solinus ſcribit de Bonaſo, &c. Ita & Lupus urinam ſpargit in perſequentem. Ol. Mag. Hiſt. l. 19. c. 14.

(*p*) Thus againſt the *Crocodile*, which can catch its Prey only before it, not on one Side. So the *Shark*, of which take my often-commended Friend Sir *Hans Sloane*'s Obſervation:

I;

By ſuch Shifts and Means as theſe, a ſufficient Guard is miniſtred to every Species of Animals, in its proper reſpective Place; abundantly enough to ſecure the Species from Deſtruction, and to keep up that Balance, which I have formerly ſhew'd, is in the World among every, and all the Species of Animals; but yet not enough to ſecure Individuals, from becoming a Prey to Man, or to other Creatures, as their Neceſſities of Life require. To which Purpoſe, the natural Sagacity and Craft of the one intrapping (*q*), and captivating, being in ſome Meaſure equivalent to that of the other in evading, is as excellent a Means for the maintaining the one, as preſerving the other; and if well conſider'd, argues the Contrivance of the Infinitely Wiſe Creator and Preſerver of the World.

hath this particular to it, with ſome others of its own Tribe; that the Mouth is in its under Part, ſo that it muſt turn the Belly upwards to Prey. And was it not for that Time it is in turning, in which the purſu'd Fiſhes eſcape, there would be nothing that could avoid it; for it very quick in Swimming, and hath a vaſt Strength, with the largeſt Swallow of any Fiſh, and is very devouring. Sloane's *Voyage to* Jamaica, p. 23.

(*q*) See *Chap.* 11. *Note* (*iii*).

CHAP. XV.

Of the Generation of ANIMALS.

THere remains now only one Thing more of the ten Things in common to Animals, and that is what relates to their Generation (*a*), and Conſervation

(*a*) *Spontaneous Generation*, is a Doctrine ſo generally explodced, that I ſhall not undertake the Diſproof of it. It is ſo evident,

evident, that all Animals, yea, Vegetables too, owe their Production to Parent-Animals and Vegetables; that I have often admir'd at the Sloath and Prejudices of the ancient Philosophers, in so easily taking upon Trust the *Aristotelian*, or rather, the *Ægyptian* Doctrine of *Equivocal Generation*; that when they saw *Flies*, *Frogs* and *Lice*, for Instance, to be Male and Female, and accordingly to ingender, lay Eggs, &c. they could ever imagine any of these Creatures should be spontaneously produc'd, especially in so Romantick a Manner, as in the Clouds; as they particularly thought *Frogs* were, and that they drop'd down in Showers of Rain. For an Answer to this Case of *Frogs*, I shall refer to a Relation of my own, which my late most ingenious, and learned Friend, the great Mr. *Ray*, requested of me, and was pleas'd to publish in his last Edition of his *Wisdom of God manifested*, &c. *p.* 365.

But some will yet assert the Raining of *Frogs*; among which the curious Dr. *Plot* is somewhat of this Opinion; telling us of *Frogs* found on the Leads of the Lord *Aston*'s Gate-house, at *Tixal* in *Staffordshire*, which he thinks by some such Means came there; as also on the Bowling-Green, frequently after a Shower of Rain. *Plot*'s *Hist. Staff. c.* 1. *sect.* 47.

But we may take a Judgment of this, and an Hundred such like Reports, to be met with in considerable Authors, from other the like Reports that have been better enquir'd into. In a Scarcity in *Silesia*, a mighty Rumour was spread of it *raining Millet-Seed*; but the Matter being enquir'd into, 'twas found to be only the Seeds of the *Ivy-leaved Speedwell*, or *small Henbit*, growing in the Place in great Plenty. *Eph. Germ. An.* 3. *Obs.* 40. So in the *Archipelago*, it was thought Ashes were rain'd, Ships being cover'd therewith at an hundred Leagues Distance; but in all Probability, it was from an Eruption of *Vesuvius*, that then happen'd. About *Warminster* in *Wilts*, 'twas reported it *rain'd Wheat*; but a curious Observer, Mr. *Cole*, found it to be only *Ivy-Berries*, blown thither in a considerable Quantity by a Tempest. In the Year 1696 at *Cranstead* near *Wrotham* in *Kent*, a Pasture-Field was over-spread with little young *Whitings*, suppos'd to fall from the Clouds, in a Tempest of Thunder and Rain; but doubtless they were brought thither with Waters from the Sea by the Tempest. See the before-commended Mr. *Lowth. Abridg. Phil. Trans. Vol.* 2. *p.* 143, 144.

Neither needeth it seem strange, that *Ashes*, *Ivy-Berries*, *small Fishes*, or young *Frogs*, (which yet may have some other Conveyance,) should be thus transported by tempestuous Winds, considering to what Distance, and in what Quantities the Sea-Waters were carry'd by the *Great Storm*, *Novemb.* 26

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tion of their Species (*b*), by that Means. It ould not be ſeemly to advance far in this admi- ble Work of God; neither ſhall I at all inſiſt up- that of Man for the ſame Reaſon. And as for e Irrationals (*c*), I ſhall confine my ſelf to theſe e Matters. I. Their

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93, of which an ingenious Friend ſent me theſe Accounts m *Lewes* in *Suſſex*, viz. *That a Phyſician travelling ſoon after the rm*, to Tiſehurſt, *twenty Miles from the Sea, as he rode along k'd ſome Tops of Hedges, and chewing them, found them Salt: That* e Grapes *hanging on the Vines at* Lewes *were ſo too. That Mr.* lliamſon, *Rector of* Ripe, *found the Twigs in his Garden Salt the* nday *after the Storm; and others obſerv'd the ſame a Week after. t the Graſs of the Downs about* Lewes, *was ſo Salt, that the Sheep ld not feed till Hunger compell'd them: And that the* Miller *of* rwick, (*three Miles from the Sea,*) *attempting with his Man to ſe- e his Mill, were ſo waſh'd with Flaſhes of Sea-Water, like the eakings of Waves againſt the Rocks, that they were almoſt ſtrangled rewith, and forced to give over their Attempt.*

I call'd this Doctrine of *Equivocal Generation*, an *Ægyptian ctrine*; becauſe probably it had its Riſe in *Ægypt*, to ſalve e Hypotheſis of the Production of Men, and other Animals, t of the Earth, by the Help of the Sun's Heat. To prove hich, the *Ægyptians*, (as *Diod. Sicul* ſaith,) *produce this Obſerva- n, That about* Thebes, *when the Earth is moiſtned by the* Nile, *by Intenſe Heat of the Sun, an innumerable Number of* Mice *do ſpring* . From whence he infers, That all Kinds of Animals, ight as well at firſt come likewiſe out of the Earth. And om theſe the learned Biſhop *Stillingfleet* thinks other Wri- rs, as *Ovid*, *Mela*, *Pliny*, &c. have, without examining its ruth, taken up the ſame Hypotheſis. *Vid. Stillingfleet's Orig. cr. Part.* 2. *Book* I. *Chap.* 1.

The before-commended Dr. *Harris*, from the Obſervations Dr. *Harvey*, Sr. *Malpighi*, Dr. *de Graaf*, and Mr. *Lewenhoeck*, fers three Things concerning *Generation* as highly probable. *That Animals are* ex Animalculo. 2. *That the Animalcules e originally* in ſemine Marium, & non in Fœminis. 3. *That ey can never come forward, or be formed into Animals of the reſpec- e Kind, without the* Ova in Fœminis. His Proofs and Illu- rations, ſee under the Word *Generation*, in his *Lex. Techn. ol.* 2.

(*b*) *At certè Naturæ, ſi fieri potuiſſet, maximè optâſſet ſuum opifi- um eſſe immortale: quod cum per materiam non liceret (nam quod*

——*ex*

I. Their natural Sagacity in chuſing the fitteſt Places to repoſite their Eggs and Young.

II. The fitteſt Times and Seaſons they make uſe of for their Generation.

III. The due and ſtated Number of their Young.

IV. Their Diligence and earneſt Concern in their Breeding up.

V. Their Faculty of Feeding them, and their Art and Sagacity exerted therein.

I. The natural Sagacity of irrational Animals, in chuſing the fitteſt Places to repoſite their Eggs and Young. Of this I have given larger Hints already than I needed to have done, when I ſpake of the Architecture (*d*) of Animals, intending then to have wholly paſs'd by this Buſineſs of Generation: I ſhall therefore now only ſuperadd a few other Inſtances, the more to illuſtrate this Matter.

It hath been already ſhewn, and will hereafter (*e*) farther appear, that the Places in which the ſeveral Species of Animals lay up their Eggs, and Young, are the beſt for that Purpoſe; Waters (*f*) for

——*ex carne eſt compoſitum, incorruptibile eſſe non poteſt*) *ſubſidium quod potuit ipſi ad immortalitatem eſt fabricata, ſapientis cujuſdam urbis conditoris exemplo, &c. Nam mirabilem quandam rationem invenit, quomodo in demortui animalis locum, novum aliud ſufficiat.* Galen. de Uſu Part. l. 14. c. 22.

(*c*) *Animantia Bruta Obſtetricibus non indigent in edendo Partu eum inditâ Naturæ vi Umbilicus ſeipſum occludat.* Ol. Rudbeck in Blaſii Anat. Felis.

(*d*) *Chap.* 13.

(*e*) *Book* VIII. *Chap.* 6.

(*f*) The *Ephemeron*, as it is an unuſual and ſpecial Inſtance of the Brevity of Life; ſo I take to be a wonderful Inſtance of the ſpecial Care and Providence of God, in the Conſervation of the Species of that Animal. For, 1. As an Animal whoſe Life is determin'd in about five or ſix Hours Time, (*viz.*

or one; Fleſh for another; Holes in Wood (*g*), Earth, or Stone (*h*), for others; and Neſts for others; and we ſhall find, that ſo ardent is the Propenſity of all Animals, even of the meaneſt Inſects, to get a fit Place for the Propagation of their Young; that, as will hereafter appear, there is ſcarce any Thing that eſcapeth the Inqueſt of thoſe little ſubtile Creatures. But beſides all this, there are two or three Things more obſervable, which plainly argue the Inſtinct of ſome Superior Rational Being. As,

1. The compleat and neat Order which many Creatures obſerve in laying up their Seed, or Eggs, in proper Repoſitories: Of which I ſhall ſpeak in another Place (*i*).

2. The ſuitable Apparatus in every Creature's Body, for the laying-up its Eggs, Seed, or Young, in

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viz. from about ſix in the Evening, till about Eleven a Clock at Night,) needs no Food; ſo neither doth the *Ephemeron* eat, after it is become a *Fly*. 2. As to its Generation; in thoſe five Hours of its Life, it performs that, and all other neceſſary Offices of Life: For in the Beginning of its Life, it ſheds its Coat; and that being done, and the poor little Animal thereby render'd light and agile, it ſpends the reſt of its ſhort Time in friſking over the Waters, and at the ſame time the Female droppeth her Eggs on the Waters, and the Male his Sperm on them to impregnate them. Theſe Eggs are ſpread about by the Waters; deſcend to the Bottom by their own Gravity; and are hatch'd by the Warmth of the Sun, into little Worms, which make themſelves Caſes in the Clay, and feed on the ſame without any Need of parental Care. *Vid. Ephem. vita*, tranſlated by Dr. *Tyſon* from *Swammerdam*. See alſo *Book* VIII. *Chap.* 6. *Note* (*r*).

(*g*) See *Chap.* 13. *Note* (*c*), and *Book* VIII. *Chap.* 6.

(*h*) The *Worms* in *Chap.* 11. *Note* (*x*) breed in the Holes they gnaw in Stone, as is manifeſt from their Eggs found therein.

(*i*) See *Book* VIII. *Chap.* 6. *Note* (*q*).

(*k*) Many,

in their proper Place. It would be as endleſs and needleſs to name all Particulars, and therefore an Inſtance or two of the Inſect-Tribe may ſerve for a Specimen in this Place, till I come to other Particulars. Thus Inſects, who have neither Feet adapted to ſcratch, nor Noſes to dig, nor can make artificial Neſts to lay up their Young; yet what abundant Amends is there made them, in the Power they have either to extend the *Abdomen* (*k*), and there-

(*k*) Many, if not moſt Flies, eſpecially thoſe of the Bee-*Fly*-kind, have a Faculty of extending their *Uropygia*, and thereby are enabled to thruſt their Eggs into convenient Holes and Receptacles for their Young, in Fleſh, and whatever elſe they Fly-blow, but none more remarkable than the *Horſe-Fly*, called by *Pennius*, in *Mouffet*, (p. 62.) Σκολιὸς, i. e. *Curvicauda*, and the *Whame* or *Burrel-Fly*, which is vexatious to Horſes in Summer, not by ſtinging them, but only by their bombylious Noiſe, or tickling them in ſticking their Nits, or Eggs on the Hair; which they do in a very dexterous Manner, by thruſting out their *Uropygia*, bending them up, and by gentle, ſlight Touches, ſticking the Eggs to the Hair of the Legs, Shoulders, and Necks, commonly of Horſes; ſo that Horſes which go abroad, and are ſeldom dreſſed, are ſomewhat diſcoloured by the numerous Nits adhering to their Hair.

Having mentioned ſo much of the Generation of this Inſect, although it be a little out of the Way, I hope I ſhall be excuſed for taking Notice of the long-tailed Maggot, which is the Product of theſe Nits or Eggs, called by Dr. *Plot*, *Eruca Glabra*, [or rather *Eula Scabra*, it ſhould be] *caudata aquatico-arborea*, it being found by him in the Water of an hollow Tree; but I have found it in Ditches, Saw-Pits, Holes of Water in the High-way, and ſuch-like Places where the Waters are moſt ſtill and foul. This Maggot I mention, as being a ſingular and remarkable Work of God, not ſo much for its being ſo utterly unlike as it is to its Parent *Bee*-like Fly, as for the wiſe Proviſion made for it by its long Tail, which is ſo jointed at certain Diſtances from the Body, as that it can be withdrawn, or ſheathed, one Part within another, to what Length the Maggot pleaſeth, ſo as to enable it to reach the Bottom of very ſhallow, or deeper Waters, as it hath

ereby reach the commodious Places they could ot otherwiſe come at; or elſe they have ſome acu- ous Part or Inſtrument to terebrate, and make Vay for their Eggs into the Root (*l*), Trunk (*m*), Fruit

th Occaſion, for the gathering of Food. At the End of is tapering is a Ramification of *Fibrillæ*, or ſmall Hairs, re- eſenting, when ſpread, a Star; with the Help of which, read out on the Top of the Waters, it is enabled to hang, aking, by that Means, a ſmall Depreſſion or Concavity on e Surface of the Water. In the midſt of this Star, I ima- ne the Maggot takes in Air, there being a Perforation, hich with a Microſcope I could perceive to be open, and the Star to be guarded againſt the Incurſion of the ater.

(*l*) The Excreſcences on the Root of *Cabbages*, *Turneps*, and ers other Plants, have always a Maggot in them; but what e Animal is that thus makes it's Way to the Root under round, whether *Ichneumon*, *Phalæna*, *Scarab*, or *Scolopendra*, I uld never diſcover, being not able to bring them to any hing in Boxes.

(*m*) I preſume they are only of the *Ichneumon-Fly-kind*, that ve their Generation in the Trunks of Vegetables. In *Mal- hi de Gallis*, *Fig.* 61. is a good Cut of the gouty Excreſcences, rather Tumours of the *Briar-Stalk*: From which proceeds ſmall black *Ichneumon-Fly*, with red *Legs*; black, ſmooth inted *Antennæ*; pretty large *Thorax*; and ſhort, round *Belly*, the Shape of an Heart. It leapeth as a *Flea*. The *Male*, s in other Inſects,) is leſſer than the *Female*, and very vene- ous, in ſpite of Danger, getting upon the *Female*, whom ey beat and tickle with their Breeches and Horns, to ex- te them to a *Coit*.

Another Example of the Generation in the Trunks of Ve- tables, ſhall be from the Papers of my often-commended riend Mr. *Ray*, which are in my Hands, and that is an Ob- rvation of the ingenious *Dr.* Nathaniel Wood: *I have* (ſaid e) *lately obſerved many Eggs in the common Ruſh; one Sort are little anſparent Eggs, in Shape ſomewhat like a Pear, or Retort, lying ithin the Skin, upon, or in the* Medulla, *juſt againſt a browniſh Spot the out-ſide of the Ruſh; which is apparently the Creatrix of the ound made by the Fly, when ſhe puts her Eggs there. Another Kind much longer, and not ſo tranſparent, of a long Oval, or rather cylin- ical Form; ſix, eight, or more, lie commonly together, acroſs the Ruſh,*

Fruit (*n*), Leaves (*o*), and the tender Buds of Vegetables (*p*), or ſome other ſuch curious and ſecure Method they are never deſtitute of. To which we may add,

3. The natural Poiſon (*q*), (or what can I call it?) which many, or moſt of the Creatures, laid intended, have, to cauſe the Germination of ſuch Balls

Ruſh, parallel to each other, like the Teeth of a Comb, and are as long as the Breadth of the Ruſh. Letter from *Kilkenny* in *Ireland*, April the 28th, 1697.

(*n*) See *Book* VIII. *Chap.* 6. *Note* (*d*).

(*o*) I have in *Chap.* 13. *Note* (*u*), and *Book* VIII. *Chap.* 6. *Note* (*e*), (*f*), taken Notice of the Nidification and Generation of ſome Inſects, on the Leaves of Vegetables, and ſhall therefore, for the Illuſtration of this Place, chuſe an uncommon Example out of the *Scarab-kind* (the Generation of which Tribe hath not been as yet mentioned) and that is, of a ſmall *Scarab* bred in the very Tips of *Elm-Leaves*. Theſe Leaves, in Summer, may be obſerved to be, many of them, dry and dead, as alſo turgid; in which lieth a dirty, whitiſh, rough Maggot. From which proceeds a *Beetle* of the ſmalleſt Kind, of a light, *Weeſle* Colour, that leapeth like a *Graſſhopper*, although its Legs are but ſhort. Its Eyes are blackiſh, *Elytra* thin, and prettily furrowed, with many Concavities in them; ſmall club-headed *Antennæ*, and a long *Roſtrum* like a *Proboſcis*.

The ſame, or much like this, I have met with on Tips of *Oaken* and *Holly-Leaves*. How the *Scarab* lays its Eggs in the Leaf, whether by terebrating the Leaf, or whether the *Maggot*, when hatched, doth it, I could never ſee. But with great Dexterity, it makes its Way between the upper and under Membranes of the Leaf feeding upon the parenchymous Part thereof. Its Head is ſlenderer and ſharper than moſt of *Maggots*, as if made on Purpoſe for this Work; but yet I have often wondered at their Artifice, in ſo nicely ſeparating the Membranes of the *Elm-Leaf*, without breaking them, and endangering their own tumbling out of 'em, conſidering how thin, and very tender the Skins of that Leaf (particularly) are.

(*p*) See *Book* VIII. *Chap.* 6. *Note* (*z*).

(*q*) See *Book* VIII. *Chap.* 8. to *Note* (*bb*), &c.

(*r*) Flo

balls, Caſes, and other commodious Repoſitories; as are an admirable Lodgment to the Eggs and Young; that particularly aſſiſt in the Incubation and Hatching the Young, and then afford them ſufficient Food and Nouriſhment in all their *Nymha-State*, in which they need Food; and are afterwards commodious Houſes and Beds for them in their *Aurelia-State*, till they are able to break priſon, fly abroad, and ſhift for themſelves. But this ſhall be taken Notice of, when I come to treat of Inſects.

II. As irrational Animals chuſe the fitteſt Place, ſo alſo the fitteſt Times and Seaſons for their Generation. Some indeed are indifferent to all Times; but others make uſe of peculiar Seaſons (*r*). Thoſe, for Inſtance, whoſe Proviſions are ready at all Seaſons; or who are under the Tuition of Man, produce their Young without any great Regard to Heat or Cold, Wet or Dry, Summer or Winter. But others, whoſe Proviſions are peculiar, and only to be met with at certain Seaſons of the Year; or who, by their Migration, and Change of Place, are tied up to certain Seaſons; theſe (as if endowed with a natural Care and Foreſight of what ſhall happen) do accordingly lay, hatch, and nurſe up their Young in the moſt proper Seaſons of all the Year for their Purpoſe; as in Spring, or Summer, the Times of Plenty of Proviſions, the Times of Warmth for Incubation, and the moſt proper Seaſons to breed up their Young, till they are able to ſhift for themſelves, and

(*r*) Πολλὰ δὲ καὶ πρὸς τὰς ἐκτροφὰς τῶν τέκνων σοχαζόμενα, τοιῦνται τὸν συνδυασμὸν ἐν τῇ ἀναρτιζέσῃ ὥρᾳ. Artiſt. Hiſt. An. l. 5. c. 8. ubi plura.

and can range about for Food, and ſeek Places of Retreat and Safety, by flying long Flights as well as their Progenitors, and paſſing into far diſtant Regions, which (when others fail) afford thoſe helpleſs Creatures the Neceſſaries of Life.

III. To the ſpecial Seaſons, I may add the peculiar Number of Young produced by the irrational Creatures. Of which I have already taken ſome Notice, when I ſpake of the Balance of Animals (*s*). Now, if there was not a great deal more than Chance in this Matter, even a Wiſe Government of the Creation, it could never happen that every Species of Animals ſhould be tied up to a certain Rate and Proportion of its Increaſe; the moſt uſeful would not be the moſt fruitful, and the moſt pernicious produce the feweſt Young, as I have obſerved it commonly is. Neither would every Species produce ſuch a certain Rote as it is only able to breed up: But all would be in a confuſed, huddled State. Inſtead of which, on the contrary, we find every Thing in compleat Order; the Balance of *Genera*, Species and Individuals always proportionate and even; the Balance of Sexes the ſame; moſt Creatures tied up to their due Stint and Number of Young, without their own Power and Choice, and others (particulary of the winged (*t*) Kind

(*s*) See *Chap.* 10.

(*t*) Mr. *Ray* alledges good Reaſons to conclude, That although Birds have not an exact Power of numbering, yet that they have of diſtinguiſhing many from few, and knowing when they come near to a certain Number; and that they have it in their Power to lay many or few Eggs. All which he manifeſteth from *Hens*, and other domeſtick Fowls laying many more Eggs when they are withdrawn, than when

Kind) producing their due Number at Choice and Pleaſure; ſome large Numbers, but not more than they can cover, feed and foſter; others fewer, but as many as they can well nurſe and breed up. Which minds me,

IV. Of the Diligence and earneſt Concern which irrational Animals have of the Production and Breeding up their Young. And here I have already taken Notice of their Στοργὴ, or natural Affection, and with what Zeal they feed and defend their Young. To which may be added theſe two Things:

1. The wonderful Inſtinct of Incubation. It is utterly impoſſible, that ever unthinking, untaught Animals ſhould take to that only Method of hatching their Young, was it not implanted in their Nature by the Infinitely Wiſe Creator. But ſo ardent is their Deſire, ſo unwearied is their Patience when they are ingaged in that Buſineſs, that they will abide their Neſts for ſeveral Weeks, deny themſelves the Pleaſures, and even the Neceſſaries of Life; ſome of them even ſtarving themſelves almoſt, rather than Hazard their Eggs, to get Food; and others either performing the Office by Turns (*u*), or elſe the one kindly ſeeking out, and carrying Food to the other (*w*), engaged in the Office

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when not. Which holds in wild as well as domeſtick Birds, as appears from Dr. *Liſter*'s Experiment in withdrawing a Swallow's Eggs, which by that Means laid nineteen Eggs ſucceſſively before ſhe gave over. *Vide* Ray's *Wiſdom of God*, &c. *p.* 137.

(*u*) *Palumbes incubat fœmina poſt meridiana in matutinum, cætero mas. Columbæ incubant ambo, interdiu Mas, noctu Fœmina.* Plin. Nat. Hiſt. l. 10. c. 58.

(*w*) Of the common *Crow*, Mr. *Willughby* ſaith, *The Females*

Office of Incubation. But of theſe Matters in a more proper Place (*x*).

2. When the youug ones are produced, not only with what Care do they feed and nurſe them; but with what ſurprizing Courage do all or moſt Creatures defend them! It is ſomewhat ſtrange to ſee timid Creatures (*y*), who at other Times are cowardly, to be full of Courage, and undaunted at that Time; to ſee them furiouſly and boldly encounter their Enemy, inſtead of flying from him; and expoſe themſelves to every Danger, rather than hazard and forſake their Young.

With this earneſt Concern of the irrational Animals for their Young, we may join in the

V. And laſt Place, Their Faculty and Sagacity of feeding them. About which I ſhall take Notice of three Things.

1. The Faculty of Suckling the Young, is an excellent Proviſion the Creator hath made for thoſe helpleſs Creatures. And here the Agreeableneſs and Suitableneſs of that Food to young Creatures, deſerves particular Obſervation; as alſo their Delight in it, and Deſire and Endeavours after it, even as ſoon

males only ſit, and that diligently, the Males in the mean Time bring them Victuals; as Ariſtotle *ſaith. In moſt other Birds, which pair together, the Male and Female ſit by Turns.* Ornithol. lib. 2. ſect. 1. cap. 2. ſect. 2. And I have obſerved the Females Crows to be much fatter than the Males, in the Time of Incubation; by Reaſon the Male, out of his conjugal Affection, almoſt ſtarves himſelf, to ſupply the Female with Plenty.

(*x*) See *Book* VII. *Chap.* 4.

(*y*) *Volucribus Natura novam quandam, Pullos educandi, rationem excogitavit: ipſis enim præcipuum quendam amorem in ea quæ procrearent, ingeneravit, quo impulſu bellum pro pullis cum ferocibus animalibus, quæ ante declinârunt, intrepidè ſuſcipiunt, victúmque ipſis convenientem ſuppeditant.* Galen de Uſ. Part. l. 14. c. 4.

(*z*)

ſoon as born (z), together with the Willingneſs of all, even the moſt ſavage and fierce Animals, to part with it, and to adminiſter it to their Young, yea, to teach and inſtitute them in the Art of taking it.

And laſtly, to name no more, the curious *Apparatus* which is made for this Service in the divers ſpecies of Animals, by a due Number of Breaſts, proportionable to the Occaſions of each Animal, by curious Glands in thoſe Breaſts, to ſeparate that nutritive Juice, the Milk, by Arteries and Veins to convey it to them, and proper Rivulets and Chanels to convey it from them, with Dugs and Nipples, placed in the moſt convenient Part of the Body (*aa*) of each Animal, to adminiſter it to their Young; all theſe Things, I ſay, do manifeſtly proclaim the Care and Wiſdom of the Great Creator. 2. As

(z) *In iis animantibus quæ lacte aluntur, omnis ferè cibus matrum lacteſcere incipit: eaque, quæ paulo antè nata ſunt, ſine magiſtro, duce naturâ, mammas appetunt, earumque ubertate ſaturantur. Atque ut intelligamus nihil horum eſſe fortuitum, & hæc omnia eſſe provida, ſcientiſque naturæ, quæ multiplices fœtus procreant, ut Sues, ut Canes, his Mammarum data eſt multitudo; quas eaſdem paucas habent eæ beſtiæ, quæ pauca gignunt.* Cic. de Nat. Deor. l. 2. c. 51. *Conſule quoque* Galen de Uſ. Part. l. 14. c. 4. & l. 15. c. 7.

(*aa*) *Animalia ſolidipeda, & ruminantia, vel cornigera, inter femora Mammas habent, quorum Fœtus ſtatim à partu pedibus inſiſtunt, quòd matres inter lactandum non decumbant, ut Equa, Aſina, &c. Animalia digitata & multipara in medio ventre, ſcil. ſpatio ab inguine ad pectus (in Cuniculo uſque ad jugulum) duplicem mammarum ſeriem ſortita ſunt, quæ omnia decumbentia ubera fœtibus admovent, ut Urſa, Leæna, &c. Si verò hæc in ſolo inguine Mammas gererent, propria cura inter decumbendum fœtûs acceſſum ad mammas nonnihil præpedirent. Mulieribus Mammæ binæ ſunt, ut & Papillæ, nimirum ut latus lateri conformiter reſpondeat, & ut alternatim infans à latere in latus inter ſugendum transferatur, ne corpus ejus uni lateri nimis aſſueſcens quoquo modo incurvetur. Simia, homo Sylveſtris, &c.* Blaſ. Anat. Animal. Part. 1. Cap. 6. *de Cane ex Whartono.* See here what *Pliny* hath alſo, *Lib.* 11. *Cap.* 40.

2. As for ſuch Animals as do in another Manner breed up their Young, by finding out Food, and putting it into their Mouth, the Proviſion made in them for this Service, to ſtrike, catch, to pouch and convey their Prey and Food to their Young (*bb*), is very conſiderable. And ſo is alſo their Sagacity in equally diſtributing it among them, that among many, all ſhall be duly, equally, and in good Order, fed.

3. There

In the *Elephant*, the Nipples are near the Breaſt, by Reaſon the old One is forced to ſuck her ſelf, and by the Help of her Trunk conveys the Milk into the Mouth of her Young. *Vide Phil. Tranſ.* No. 336.

(*bb*) For an Exemplification, I might name many Animals, particularly Birds, whoſe Parts are compleatly ſuited to this Service. They are Characteriſticks of rapacious Birds, to have aduncous Bills and Talons to hold and tear; and ſtrong brawny Thighs to ſtrike and carry their Prey; as well as a ſharp piercing Sight to ſpy it afar off. *Raii Synopſ. Method. Av. p.* 1. The *Pelecane* alſo might be here named, for its prodigious Bag under its Bill and Throat, big enough to contain thirty Pints. *Id. ibid. p.* 122. And to name no more, the common *Heron* hath its moſt remarkable Parts adapted to this Service; long Legs for wading; and a long Neck anſwerable thereto to reach Prey; a wide, extenſive Throat to pouch it; long Toes, with ſtrong hooked Talons, (one of which is remarkably ſerrate on the Edge) the better to hold their Prey; a long ſharp Bill to ſtrike their Prey, and ſerrate towards the Point, with ſharp hooked Beards ſtanding backward, to hold their Prey faſt when ſtruck; and laſtly, large, broad, concave Wings (in Appearance much too large, heavy, and cumberſome for ſo ſmall a Body, but) of greateſt Uſe to enable them to carry the greater Load to their Neſts, at ſeveral Miles Diſtance; as I have ſeen them do from ſeveral Miles beyond me, to a large Heronry above three Miles diſtant from me. In which I have ſeen *Plaiſe*, and other Fiſh, ſome Inches long, lying under the high Trees in which they build; and the curious and ingenious Owner thereof, *D' Acre Barret*, Eſq; hath ſeen a large *Eel* convey'd by them, notwithſtanding the great Annoyance it gave them in their Flight, by its twiſting this Way and that Way about their Bodies.

(*cc*) This

3. There is yet another Inſtinct remaining, of ſuch Animals as can neither adminiſter Suck to their Young, neither lay them in Places affording Food, nor can convey and bring them Food, but do with their Eggs, lay up Proviſions for their future Young. Somewhat of this is reported of ſome Birds (*cc*); but I have my ſelf, with Pleaſure, frequently ſeen ſome of the Species of Inſects to carry ample Proviſions into their dry and barren Cells, where they have ſealed them carefully and cautiouſly up with their Eggs, partly, it is like, for Incubation-Sake, and partly as an eaſy Bed to lodge their Young; but chiefly, for future Proviſion for their Young, in their *Nympha-State*, when they ſtand in Need of Food (*dd*).

(*cc*) This is reported of the *American Oſtrich*, mentioned by *Acarette*, in *Philoſoph. Tranſ.* No. 89. Of which ſee *Book* VII. *Chap.* 4. *Note* (*e*).

(*dd*) *Hornets*, *Waſps*, and all the Kinds of *Bees* provide Honey; and many of the *Pſeudoſphecæ*, and *Ichneumon Waſps* and *Flies*, carry *Maggots*, *Spiders*, *&c.* into their Neſts; of which ſee above, *Chap.* 13. *Note* (*c*).

CHAP. XVI. *The Concluſion.*

THUS I have, as briefly as well I could (and much more briefly than the Matters deſerved) diſpatched the Decad of Things I propoſed in common to the ſenſitive Creatures. And now let us pauſe a little, and reflect. And upon the whole Matter, what leſs can be concluded than that there is a Being Infinitely Wiſe, Potent, and Kind, who is able to contrive and make this Glorious Scene of Things, which I have thus given only a Glance of?

For what leſs than Infinite, could Stock ſo vaſt a Globe with ſuch a noble Set of Animals? All ſo contrived, as to miniſter to one another's Help ſome Way or other, and moſt of them ſerviceable to Man peculiarly, the Top of this lower World, and who was made, as it were, on Purpoſe to obſerve, and ſurvey, and ſet forth the Glory of the Infinite *Creator*, manifeſted in His Works! Who! What, but the Great GOD could ſo admirably provide for the whole Animal World every Thing ſerviceable to it, or that can be wiſhed for, either to conſerve its Species, or to miniſter to the Being or Well-being of Individuals! Particularly, who could *Feed* ſo ſpacious a World, who could pleaſe ſo large a Number of Palates, or ſuit ſo many Palates to ſo great a Variety of Food, but the Infinite Conſervator of the World! And who but the ſame Great HE, could provide ſuch commodious *Cloathing* for every Animal; ſuch proper *Houſes*, *Neſts*, and *Habitations*; ſuch ſuitable *Armature* and *Weapons*; ſuch *Subtilty*, *Artifice*, and *Sagacity*, as every Creature is more or leſs armed and furniſhed with, to fence off the Injuries of the Weather, to reſcue it ſelf from Dangers, to preſerve it ſelf from the Annoyances of its Enemies; and, in a Word, to conſerve its Self, and its Species! What but an Infinite Superintending Power could ſo equally *Balance* the ſeveral Species of Animals, and conſerve the *Numbers* of the Individuals of every Species ſo even, as not to Over or Under-people the Terraqueous Globe! Who, but the Infinite Wiſe LORD of the World, could allot every Creature its moſt ſuitable *Place* to live in, the moſt ſuitable Element to *Breath*, and *Move*, and *Act* in. And who

who but HE could make ſo admirable a Set of organs, as thoſe of Reſpiration are, both in Land and Water-Animals! Who could contrive ſo curious a Set of Limbs, Joints, Bones, Muſcles, and Nerves, to give to every Animal the moſt commodious Motion to its State and Occaſions! And to name no more, What Anatomiſt, Mathematician, Workman, yea, Angel, could contrive and make ſo various, ſo commodious, and every Way ſo exquiſite a Set of Senſes, as the *Five Senſes* of Animals have; whoſe Organs are ſo dexterouſly contrived, ſo conveniently placed in the Body, ſo neatly adjuſted, ſo firmly guarded, and ſo compleatly ſuited to every Occaſion, that they plainly ſet forth the Agency of the Infinite Creator and Conſervator of the World.

So that here, upon a tranſient View of the Animal World in General only, we have ſuch a Throng of Glories, ſuch an enraviſhing Scene of Things as may excite us to Admire, Praiſe, and Adore the Infinitely Wiſe, Powerful, and Kind CREATOR; to condemn all *Atheiſtical* Principles; and with Holy *David*, *Pſalm* xiv. 1. to conclude, That he is in good Earneſt a *Fool*, that dares to ſay, *There is no GOD*, when we are every where ſurrounded with ſuch manifeſt Characters, and plain Demonſtrations of that Infinite Being.

But in the next BOOK we ſhall ſtill find greater Tokens, if poſſible, when I come to take a View of Animals in Particular.

A SUR-



A

SURVEY

Of the Particular

Tribes of *ANIMALS.*

IN the foregoing BOOK, having taken a View of the Things in common to Animals, my Buſineſs in the next, will be to inſpect the particular Tribes, in order to give further Manifeſtations of the Infinite Creator's Wiſdom, Power and Goodneſs towards the Animal World.

BOOK V.

A SURVEY *of* MAN.

THE firſt *Genus* of Animals that I ſhall take Notice of, ſhall be MAN, who may juſtly claim the Precedence in our Diſcourſe, inaſmuch as GOD hath given him the Superiority in the Animal World; *Gen.* i. 26. *And God ſaid*

id, Let us make Man in our Image, after our ikeneſs; and let them have Dominion over the ſh of the Sea, and over the Fowl of the Air, d over the Cattle, and over all the Earth, d over every creeping Thing that creepeth up- the Earth.

And as to Man, we have ſo excellent a Piece of orkmanſhip, ſuch a Microſcoſm, ſuch an Abridg- nt of the Creator's Art in him, as is alone ſuffi- nt to demonſtrate the Being and Attributes of OD. Which will appear, by conſidering the *ul* and the *Body* of Man.

CHAP. I.

Of the Soul of MAN.

MY Survey of Man, I ſhall begin with the Soul of Man, by Reaſon it is his moſt Noble rt (*a*), the Copy of the Divine Image in us (*b*), which we have enough to fill us with Admira- n of the Munificence, Power, and Wiſdom of the Infinite

(*a*) *Jam verò Animum ipſum, Mentemque hominis, Rationem, Con- um, Prudentiam, qui non divinâ curâ perfecta eſſe perſpicit, is his ip- rebus mihi videtur carere.* Cic. de Nat. Deor. l. 2. c. 59.

(*b*) *Senſum à Cœleſti demiſſum traximas arce,*
Cujus egent prona, & tevram ſpectantia: mundi
Principio indulſit communis Conditor, illis
Tantùm Animas; nobis Animum quoque.
Juven. Sat. xv. V. 144.

Et cùm non aliter poſſent mortalia fingi,
Adjunxit geminas, illæ cum corpore lapſæ
Intereunt: hæc ſola manet, buſtoque ſuperſtes
Evolat.
Claud. de 4 Conſul. Hon.

(*c*) *Nam*

Infinite Creator (*c*), when we contemplate the No-ble Faculties of this our Superiour Part, the va-Reach and Compaſs of its *Underſtanding*, the pro-digious Quickneſs and Piercingneſs of its *Thought*, the admirable Subtilty of its *Invention*, the com-manding Power of its *Wiſdom*, the great Depth o its *Memory* (*a*), and in a Word, its *Divine Na-ture* and *Operations*.

But I ſhall not dwell on this, tho' the Superiou Part of Man, becauſe it is the leaſt known. Only there

(*c*) *Nam ſiquis nulli ſectæ addictus, ſed liberâ ſententiâ rerum co-ſiderationem inierit, conſpicatus in tantâ carnium ac ſuccorum collu-tantam mentem habitare; conſpicatus item & cujuſvis animalis co-ſtructionem (omnia enim declarant Opificis Sapientiam) Mentis, qu homini ineſt, excellentiam intelliget, tum opus de partium utilitate, qu prius exiguum eſſe ſibi videbatur, perfectiſſimæ Theologiæ verum prin-cipium conſtituet: quæ Theologia multò eſt major atque præſtantior tot Medicinâ.* Galen de uſu Part. l. 17. c. 1.

(*d*) Among many Examples that I could give of Perſons fa-mous for *Memory*, *Seneca*'s Account of himſelf may be one. *Hanc [Memoriam] aliquando in me floruiſſe, ut non tantùm ad uſum ſufficeret, ſed in miraculum uſque procederet, non nego. Nam & 200 nominum recitata, quo ordine erant dicta, reddebam: & ab his qui ad audiendum præceptorem noſtrum convenerunt, ſingulos verſus à ſingulis datos, cùm plures quàm 200 efficerentur, ab ultimo incipiens uſque ad primum recitabam.* After which, mention is made of the great Memory of *Latro Porcius* (*chariſſimi mihi ſodalis*, *Seneca* calls him) who retained in his Memory all the Declamations he had ever ſpoken, and never had his Memory fail him, not ſo much as in one ſingle Word. Alſo, he takes Notice of *Cyneas* Ambaſſador to the *Romans*, from King *Pyrrhus*, who in one Day had ſo well learn'd the Names of his Spectators, that *poſtero die novus homo & Senatum, & omnem urbanam circumfuſam Senatui plebem, nominibus ſuis perſalutavit.* Senec. controverſ. 1, init. Vid. quoque Plin. l. 7. c. 24. where he alſo adds o-ther Examples, *viz. Cyrus rex omnibus in exercitu ſuo militibus no-mina reddidit*; *L. Scipio populo Rom. Mithridates* 22 *gentium re totidem linguis jura dedit, pro concione ſingulas ſine interprete affatus Charmidas (ſeu potiùs Carneades) ——quæ quis exegerat volumina bibliothecis, legentis modo repræſentavit.*

(*e*) *Dicer*

ere are two Things I cannot eaſily paſs by, be-
uſe they manifeſt the eſpecial Concurrence and
eſign of the Infinitely Wiſe Creator, as having a
rticular and neceſſary Tendency to the Manage-
ent and good Order of the World's Affair. The
I. Of which is the various *Genii*, or *Inclinations*
Men's Minds to this, and that, and the other
uſineſs (*e*). We ſee how naturally Men betake
emſelves to this and that Employment: Some
light moſt in Learning and Books, ſome in Divi-
ty, ſome in Phyſick, Anatomy and Botany, ſome
Critical Learning and Philology, ſome in Ma-
ematicks, ſome in Metaphyſicks, and deep Re-
arches; and ſome have their Delight chiefly in
echanicks, Architecture, War, Navigation, Com-
erce, Agriculture; and ſome have their Inclina-
ons lie even to the ſervile Offices of the World,
d an hundred Things beſides.

Now all this is an admirably wiſe, as well as moſt
eceſſary Proviſion, for the eaſy and ſure tranſacting
e World's Affairs; to anſwer every End and Oc-
aſion of Man, yea, to make Man helpful to the
oor helpleſs Beaſts, as far as his Help is needful
them; and all, without any great Trouble, Fa-
gue, or great Inconvenience to Man; rather as a
Plea-

(*e*) *Diverſis etenim gaudet natura miniſtris,*
Ut fieri diverſa queant ornantia terras.
Nec patitur cunctos ad eandem currere metam,
Sed varias jubet ire vias, varioſque labores
Suſcipere, ut vario cultu ſit pulchrior orbis.
Paling. in Scorp.

Οὕτως ἐ παντεσσι θεὸς χαρίεντα δίδωσι
Ἀνθρώποις, &c. *Ita non omnibus hominibus ſua dona dat Deus, neque bonam indolem, neque prudentiam, nec eloquentiam: alius namque vultum*

Pleaſure and Diverſion to him. For ſo far it is from being a Toil, that the greateſt Labours (*f*) Cares, yea, and Dangers too, become pleaſant to him who is purſuing his *Genius*; and whoſe Ar dour of Inclination eggs him forward, and buoys him up under all Oppoſition, and carrieth him through every Obſtacle, to the End of his Deſigns and Deſires.

II. The next is, The *inventive* Power of the Soul (*g*). Under which I might ſpeak of many Things; but I ſhall take Notice only of Two, because they manifeſt the particular Concern and Agency of the Infinitely Wiſe Creator. The

1. Is, That *Man's Invention* ſhould reach to ſuch a great Variety of Matters; that it ſhould hit upon every Thing that may be of any Uſe, either to himſelf, or to Human Society; or, that may any Ways promote (what in him lies,) the Benefit of this lower Part of the Creation.

For the Illuſtration of this, I might take a View of all the Arts and Sciences, the Trades, yea, the very Tools they perform their Labours, and Contrivances

vultum habet deformem; ſed Deus formam eloquentiâ ornat, &c. Homer Odyſ. 8. The like alſo in *Iliad. l.* 13.

(*f*) Although *Solomon* declares, *Eccleſ.* xii. 12. *That much Study is a Wearineſs to the Fleſh*; yet we ſee with what Pleaſure and Aſſiduity many apply themſelves to it. Thus *Cicero* tells of *Cato*, whom he caſually found in *Lucullus*'s Library, *M. Catonem vidi in Bibliothecâ ſedentem, multis circumfuſum Stoicorum libris. Erat enim, ut ſcis, in eo inexhauſta aviditas legendi, nec ſatiari poterat: quippe ne reprehenſionem quidem vulgi inanem reformidans, in ipsâ curiâ ſoleret legere ſæpe, dum ſenatus cogeretur —— ut Heluo librorum —— videbatur.* Cicer. de finib. l. 3. c. 2.

(*g*) *Mentem hominis, quamvis eam non videas, ut Deum non videas tamen ut Deum agnoſcis ex operibus ejus, ſic ex memoriâ rerum, & Inventione, & celeritate motûs, omnique pulchritudine virtutis vim divinam mentis agnoſcito.* Cicer. Tuſc. Quæſt. l. 1. c. 29.

ivances with, as numerous as their Occaſions and ontrivances are various. Indeed, What is there at falleth under the Reach of Man's Senſes, that doth not employ to ſome Uſe and Purpoſe, for e World's Good? The celeſtial Bodies, the Sun, e Moon, with the other Planets, and the fix'd ars, he employs to the noble Uſes of Aſtronomy, avigation and Geography. And, What a noble umen, what a vaſt Reach muſt the Soul be en-w'd with, to invent thoſe curious Sciences of eometry and Arithmetick, both Specious, and in umbers; and thoſe nice and various Inſtruments, ade uſe of by the Geometrician, Aſtronomer, Ge-rapher and Sailor? And laſtly, What a wonder-Sagacity is ſhewn in the Buſineſs of Opticks, and rticularly in the late Invention of the Teleſcope; herewith new Wonders are diſcover'd among od's Works, in the Heavens, as there are here on rth, with the Microſcope, and other Glaſſes.

And as for this lower World, What Material is ere to be found; what kind of Earth, or Stone, Metal; what Animal, Tree, or Plant, yea, e-n the very Shrubs of the Field; in a Word, what all the excellent Variety, the Creator has fur-ſh'd the World with, for all its Uſes and Occaſi-ns, in all Ages; what, I ſay, that Man's Contri-nce doth not extend unto, and make ſome Way other advantagious to himſelf, and uſeful for uilding, Cloathing, Food, Phyſick, or for Tools or tenſils, or for even only Pleaſure and Diverſion?

But now conſidering the great Power and Ex-ent of Human Invention,

2. There is another Thing, that doth farther de-nonſtrate the Super-intendence of the Great Crea-

tor,

tor, and Conſervator of the World; and that is, That Things of great, and abſolutely neceſſary Uſe have ſoon, and eaſily occurr'd to the Invention of Man; but Things of little Uſe, or very dangerous Uſe, are rarely and ſlowly diſcover'd, or ſtill utterly undiſcover'd. We have as early as the *Moſaick* Hiſtory, an Account of the Inventions of the moſt uſeful Crafts and Occupations: Thus *Gen.* iii. 23. Adam *was ſent forth from the Garden of* Eden *by God himſelf, to till the Ground.* And in the next Chapter, his two Sons *Cain* and *Abel*; the one was of the ſame Occupation, a Tiller of the Ground, the other a Keeper of Sheep (*h*). And the Poſterity of theſe, are in the latter End of *Gen.* iv. recorded, Jabal, *to have been the Father of ſuch as dwell in Tents* (*i*); *i. e.* He was the *Inventor of Tents*, and pitching thoſe moveable Houſes in the Fields, for looking after, and depaſturing their Cattel in the Deſarts, and uncultivated World. Tubal-Cain *was an Inſtructor of every Artificer in Braſs and Iron* (*k*), or the Firſt that found out the Art of *melting, and malleating* (*l*) *Metals* and making them uſeful for Tools, aud other neceſſary Implements. And his Siſter *Naamah*, whoſe Name is only mention'd, is by ſome thought to have been the Inventor of *Spinning* and *Cloathing*. Yea, the very Art of *Muſick* is thus early aſcribed to *Jubal* (*m*); ſo indulgent was the Creator

(*h*) *Gen.* iv. 2.
(*i*) *Verſ.* 20.
(*k*) *Verſ.* 22.
(*l*) Σφυροκόπος, the LXX call him, *i. e.* A Worker with an Hammer.
(*m*) *Verſ.* 21.

(*n*) Althou

o find a Means to divert Melancholy, to cheer the pirits, and to entertain and pleaſe Mankind. But or Things of no Uſe, or but little Uſe, or of per-icious Conſequence; either they have been much ter thought of, and with great Difficulty, and rhaps Danger too, brought to paſs; or elſe they ill are, and perhaps will always remain, Exerciſes f the Wit and Invention of Men.

Of this we might give divers Inſtances: In Ma-ematicks, about ſquaring the Circle (*n*); in Mechanicks

(*n*) Although the *Quadrature of the Circle*, hath in former ges exercis'd ſome of the greateſt mathematical Wits; yet thing has been done in that Way ſo conſiderable, as in, d ſince the Middle of the laſt Century; when in the Year 57, thoſe very ingenious and great Men, Mr. *William Neile*, d my Lord *Brounker*, and Sir *Chriſtopher Wren* afterwards, the ſame Year, geometrically demonſtrated the Equality of me Curves to a ſtrait Line. Soon after which, others at ome, and Abroad, did the like in other Curves. And not ng afterwards, this was brought under an *analytical Calculus*: he firſt Specimen whereof, that was ever publiſh'd, Mr. *ercator* gave in 1688, in a Demonſtration of my Lord *ounker*'s Quadrature of the *Hyperbola*, by Dr. *Wallis*'s Reduc-on of a Fraction, into an infinite Series by Diviſion. But e penetrating Genius of Sir *Iſaac Newton*, had diſcover'd a ay of attaining the Quantity of all quadrible Curves analy-cally, by his Method of *Fluxions*, ſome Time before the ear 1668, as I find very probable from an Hiſtorical Ac-unt, in a long Letter of Mr. *Collins*, written in his own and, and ſent to *Richard Townley*, Eſq; of *Lancaſhire*, whoſe apers are in my Hands. In that Letter, Mr. *Collins* ſaith, hat *in* September 1668, *Mr.* Mercator *publiſh'd his* Logarith-otechnia, *one of which he ſoon ſent to Dr.* Barrow, *who thereupon nt him up ſome Papers of Mr.* Newton's, [now Sir *Iſaac*;] *by hich, and former Communications made thereof by the Author, to the octor; it appears that the ſaid Method was invented ſome Years be-re, by the ſaid Mr.* Newton, *and generally apply'd.* And then he oes on to give ſome Account of the Method; what it per-orms in the Circle, *&c.* what Mr. *Gregory* had done in that ind, *who intended to publiſh ſomewhat in* Latin *about it, but would*

chanicks (*o*), about the Art of Flying; and in Navigation, about finding the Longitude. These Things, although ſome of them in Appearance innocent, yea, perhaps very uſeful, yet remain for the moſt Part ſecret; not becauſe the Diſcovery of moſt of them is more impoſſible, or difficult than of many other Things, which have met with a Diſcovery; nor is it for want of Man's Diligence therein, or his careful Purſuit and Enquiry after them, (for perhaps, nothing already diſcover'd hath been more eagerly ſought after;) but with much better Reaſon, (I am ſure with greater Humility and Modeſty,) we may conclude it is, becauſe the Infinitely Wiſe Creator, and Ruler of the World, hath been pleas'd to lock up theſe Things from Man's Underſtanding and Invention, for ſome Reaſons beſt known to Himſelf, or becauſe they might be of ill Conſequence, and dangerous amongſt Men.

As in all Probability the Art of Flying would particularly be: An Art which in ſome Caſes might be of good Uſe, as to the Geographer and Philoſopher; but in other Reſpects, might prove of dangerous and fatal Conſequence: As for Inſtance, By putting it in Man's Power to diſcover the Secrets of Nations and Families, more than is conſiſtent with

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not anticipate Mr. Newton, *the firſt Inventor thereof*; with much more of this Nature. The Deſign, I find, of that indefatigable Promoter of Mathematicks, Mr. *Collins*, was to acquaint Mr. *Townley*, in his Letter, with what had been done; and to get the Aſſiſtance of that ingenious Gentleman, towards the compleating a Body of *Algebra*.

(*o*) I do not mention here the *perpetual Motion*, which hath exercis'd the mechanical Wits for many Ages; becauſe it is a Thing impoſſible, if not a Contradiction: As the before-commended Dr. *Clarke* aſſerts in *Rohaul. Phyſ.* p. 133.

(*p*) Grew's

with the Peace of the World, for Man to know; by giving ill Men greater Opportunities to do Miſchief, which it would not lie in the Power of others to prevent; and, as one (*p*) obſerves, by making Men leſs ſociable: "For upon every true or "falſe Ground of Fear, or Diſcontent, and other "Occaſions, he would have been fluttering away "to ſome other Place; and Mankind, inſtead of "cohabiting in Cities, would, like the Eagle, have "built their Neſts upon Rocks".

That this is the true Reaſon of theſe Matters, is manifeſt enough from Holy Scripture, and Reaſon (*q*) alſo gives its Suffrage thereto. The *Scriptures* expreſly tell us, That *every good Gift, and every perfect Gift, is from above, and cometh down from the Father of Lights*, St. James i. 17. *Solomon*, Prov. ii. 6. ſaith, *The Lord giveth Wiſdom; out of his Mouth cometh Knowledge and Underſtanding.* And *Elihu* is very expreſs, *Job* xxxii. 8. *But there is a Spirit in Man, and the Inſpiration of the Almighty giveth them Underſtanding*, Πνοὴ ἐστιν ἐν ἀνθρώποις καὶ ἐπίπνοια παντοκράτορος ἔστιν ἡ διδάσκουσα, as the LXX render it, *The Inſpiratus, the Afflatus of the Almighty, is their Inſtructor, Miſtreſs or Teacher.* And in Scripture, not only the more noble, ſuperiour Acts of Wiſdom or Science; but much inferiour alſo, bear the Name of Wiſdom, Knowledge and Underſtanding, and are aſcrib'd unto GOD. 'Tis well known that *Solomon*'s Wiſdom is wholly aſcrib'd unto GOD; and the Wiſdom and Underſtanding which GOD is ſaid to have given him, 1 *Kings* iv.

(*p*) Grew's *Coſmol. Sacr. l.* 1. *c.* 5. *ſect.* 25.

(*q*) *Nemo igitur vir magnus ſine aliquo afflatu divino unquam fuit.* Cic. de Nat. Deor. l. 2. c. 66.

iv. 29. is particularly set forth in the following Verſes, by his great Skill in moral and natural Philoſophy, in Poetry, and probably in Aſtronomy, Geometry, and ſuch other of the politer Sciences, for which *Ægypt*, and the *Eaſtern Nations* were celebrated of Old (*r*): *And* Solomon's *Wiſdom excelled the Wiſdom of all the Children of the Eaſt Country, and all the Wiſdom of* Ægypt. *For he was wiſer than all Men, than* Ethan, &c. *And he ſpake* 3000 *Proverbs: And his Songs were* 1005. *And he ſpake of Trees, from the Cedar to the Hyſſop of the Wall,* (*i. e.* of all Sorts of Plants;) *alſo of Beaſts, Fowl, creeping Things, and Fiſhes.* So likewiſe the Wiſdom of *Daniel*, and his three Companions, is aſcrib'd unto GOD, *Dan.* i. 17. *As for theſe four Children, God gave them Knowledge, and Skill in all Learning and Wiſdom; and* Daniel *had Underſtanding in all Viſions and Dreams.* And accordingly in the next Chapter, *Daniel* acknowledgeth and praiſeth God, *ver.* 20, 21. Daniel *anſwered and ſaid, Bleſſed be the Name of God for ever and ever, for Wiſdom and Might are his.*-----*He giveth Wiſdom unto the Wiſe, and Knowledge to them that know Underſtanding.* But not only Skill in the Superiour Arts and Sciences; but even in the more inferiour mechanick Art, is call'd by the ſame Names,

(*r*) *Ægypt*, and ſome of the *Eaſtern* Nations, are celebrated for their Skill in polite Literature; both in Scripture and profane Story: *Job* was of thoſe Parts; ſo were the Σοφοὶ and Μάγοι, the *Brachmans* and *Gymnoſophiſts*. *Moſes* and *Daniel* had their Education in theſe Parts: And *Pythagoras*, *Democritus* and others, travell'd into theſe Parts for the Sake of their Learning.

(*s*) A

Names, and aſcrib'd unto GOD: Thus for the Workmanſhip of the Tabernacle, *Exod.* xxxi. 2. to *ver.* 6. *See, I have called* Bezaleel; *and I have filled him with the Spirit of God, in Wiſdom, and in Underſtanding, and in all Manner of Workmanſhip: To deviſe cunning Works, to work in Gold, Silver and Braſs; and in cutting of Stones, to ſet them; and in carving of Timber, to work in all Manner of Workmanſhip.* So the *Spinſters, Weavers,* and other Crafts-people, are call'd wiſe-hearted, *Exod.* xxxiv. 10, 25, and other Places. And in *Exod.* xxxvi. 1, &c. the LORD is ſaid to have put this Wiſdom in them, and Underſtanding to know how to work all theſe Manner of Works, for the Service of the Sanctuary. And laſtly, to name no more Inſtances, *Hiram* the chief Architect of *Solomon*'s Temple, is in 1 *Kings* vii. 14. and 2 *Chron.* ii. 14. call'd *a cunning Man, filled with Wiſdom and Underſtanding, to work in Gold, Silver, Braſs, Iron, Stone, Timber, Purple, Blue, fine Linnen, and Crimſon; alſo to grave; and find out every Device which ſhould be put to him.*

Thus doth the Word of *God,* aſcribe the Contrivances and Crafts of Men, to the Agency, or Influence of the *Spirit of God,* and upon that of Man. And there is the ſame Reaſon for the Variety of *Genii,* or *Inclinations* of Men alſo; which from the ſame Scriptures may be concluded to be a Deſignation, and Tranſaction of the ſame Almighty Governour of the World's Affairs. And who indeed but HE, could make ſuch a Divine Subſtance, endow'd with thoſe admirable Faculties, and Powers, as the rational Soul hath; a Being to bear the

Great Creator's Vicegerency in this lower World; to employ the ſeveral Creatures; to make Uſe of the various Materials; to manage the grand Buſineſſes; and to ſurvey the Glories of all the viſible Works of God? A Creature, without which this lower World would have been a dull, uncouth, and deſolate kind of Globe. Who, I ſay, or what leſs than the *Infinite GOD*, could make ſuch a rational Creature, ſuch a Divine Subſtance as the Soul! For if we ſhould allow the *Atheiſt* any of his nonſenſical Schemes, the *Epicurean* his fortuitous Concourſe of Atoms, or the *Carteſian* (*s*) his created Matter put in Motion; yet with what tolerable Senſe could he, in his Way, produce ſuch a Divine, thinking, ſpeaking, contriving Subſtance as the Soul is; endow'd exactly with ſuch Faculties, Power, and Diſpoſitions as the various Neceſſities and Occaſions of the World require from ſuch a Creature? Why ſhould not rather all the Acts, the Diſpoſitions and Contrivances of ſuch a Creature as Man, if made in a mechanical Way, and not contriv'd

(*s*) As we are not to *accuſe* any *falſly*; ſo far be it from me to detract from ſo great a Man as Monſieur *Cartes* was? Whoſe Principles, although many have perverted to atheiſtical Purpoſes, and whoſe Notions have, ſome of them, but an ill Aſpect; yet I am unwilling to believe he was an *Atheiſt*; ſince in his *Principia Philoſophiæ*, and other of his Works, he vindicates himſelf from this Charge; and frequently ſhews ſeemingly a great Reſpect for Religion: Beſides, That many of his ſuſpicious Opinions are capable of a favourable Interpretation, which will make them appear in a better Form: Thus when he diſcardeth *final Cauſes* from his Philoſophy, it is not a Denial of them; but only excluding the Conſideration of them, for the Sake of free philoſophiſing; it being the Buſineſs of a Divine, rather than a Philoſopher, to treat of them.

(*t*) For

triv'd by God, have been the ſame? Particularly, Why ſhould he not have hit upon all Contrivances of equal Uſe, early, as well as many Ages ſince? Why not that Man have effected it, as well as this, ſome thouſands of Years after? Why alſo ſhould not all Nations, and all Ages (*t*), improve in

(*t*) For Ages of *Learning* and *Ignorance*, we may compare the preſent, and ſome of the Ages before the Reformation. The laſt Century, and the few Years of this, have had the Happineſs to be able to vie with any Age for the Number of learned Men of all Profeſſions, and the Improvement made in all Arts and Sciences; too many, and too well known to need a Specification.

But for Ignorance, we may take the ninth Age, and ſo down to the Reformation; even as low as Queen *Elizabeth*, although Learning began to flouriſh; yet we may gueſs how Matters ſtood, even among the Clergy, by her 53 *Injunct.* No. 1559. *Such as are but mean Readers, ſhall peruſe over before, once or twice, the Chapters and Homilies, to the Intent they may read to the better Underſtanding of the People, the more Encouragement of Godlineſs.* Spar. Collect. p. 82. But this is nothing, in compariſon to the Ages before, when the Monk ſaid, *Græcum non eſt legi*; or as *Eſpencæus* more elegantly hath it, *Græcè nôſſe ſuſpectum, Hebraicè prope Hæreticum.* Which Suſpicion, (ſaid the learned *Hakewill,*) *Rhemigius*, ſurely was not guilty of, in commenting upon *diffamatus*, 1 *Theſſ.* i. 8. who ſaith, that St. *Paul* ſomewhat improperly put that for *divulgatus*, not being aware that St. *Paul* wrote in *Greek*, and not in *Latin.* Nay, ſo great was their Ignorance, not only of *Greek*, but of *Latin* too, that a Prieſt baptiz'd *in nomine Patria, & Filia, Spiritua ſancta.* Another ſuing his Pariſhioners for not paving his Church, prov'd it from *Jer.* xvii. 18. *Pavèant illi, non paveam ego.* Some Divines in *Eraſmus*'s Time, undertook to prove Hereticks ought to be burnt, becauſe the Apoſtle ſaid, *Hæreticum devita.* Two Fryars diſputing about a Plurality of Worlds, one prov'd it from *Annon decem ſunt facti mundi?* The other reply'd, *Sed ubi ſunt novem?* And notwithſtanding their Service was read in *Latin*, yet ſo little was that underſtood, that an old Prieſt in *Hen.* VIII. read *Mumpſimus Domine*, for *Sumpſimus:* And being admoniſh'd of it, he ſaid, he had done ſo for thirty Years, and would not leave his old *Mumpſimus* for their new *Sumpſimus.* Vid. *Hakew. Apol.* 3. *c.* 7. *ſect.* 2.

in every Thing, as well as this, or that Age, or Nation (*u*) only? Why ſhould the *Greeks*, the *Arabians*, the *Perſians*, or the *Ægyptians* of old, ſo far exceed thoſe of the ſame Nations now? Why the *Africans* and *Americans* ſo generally ignorant and barbarous, and the *Europæans*, for the moſt part, polite and cultivated, addicted to Arts and Learning? How could it come to paſs, that the Uſe

(*u*) *There is* (*it ſeems*) *in Wits and Arts, as in all Things beſide, a kind of circular Progreſs: They have their Birth, their Growth, their Flouriſhing, their Failing, their Fading; and within a while after, their Reſurrection, and Reflouriſhing again. The Arts flouriſhed for a long Time among the* Perſians, *the* Chaldæans, *the* Ægyptians. ——*But afterwards the* Grecians *got the Start of them*, and are now become as barbarous themſelves, as formerly they eſteemed all beſides themſelves to be. About the Birth of *Chriſt*, Learning began to flouriſh in *Italy*, and ſpread all over *Chriſtendom*; till the *Goths*, *Huns*, and *Vandals*, ranſacked the Libraries, and defaced almoſt all the Monuments of Antiquity: So that the Lamp of Learning ſeemed to be put out for near the Space of 1000 Years, till the firſt *Manſor*, King of *Africa* and *Spain*, raiſed up, and ſpurred forward the *Arabian* Wits, by great Rewards and Encouragements. Afterwards *Petrarch* opened ſuch Libraries as were undemoliſhed. He was ſeconded by *Boccace*, and *John* of *Ravenna*, and ſoon after by *Aretine*, *Philelphus*, *Valla*, &c. And thoſe were followed by *Æneas Sylvius*, *Angelus Politianus*, *Hermolaus Barbarus*, *Marſilius Ficinus*, and *Joh. Picus* of *Mirandula*. Theſe were backed by *Rud. Agricola*, *Reucline*, *Melanchon*, *Joach. Camerarius*, *Wolphlazius*, *Beat. Rhenanus*, Almaines: By *Eraſmus* of *Rotterdam*; *Vives* a *Spaniard*; *Bembus*, *Sadoletus*, *Eugubinus*, Italians: *Turnebus*, *Muretus*, *Ramus*, *Pithæus*, *Budæus*, *Amiot*, *Scaliger*, Frenchmen; Sir *Tho. More* and *Linaker*, Engliſhmen. And about this Time, even thoſe Northern Nations yielded their great Men; *Denmark* yielded *Olaus Magnus*, *Holſter*, *Tycho Brahe*, and *Hemingius*; and *Poland*, *Hoſius*, *Frixius*, and *Crumerus*. But to name the Worthies that followed theſe, down to the preſent Time, would be endleſs, and next to impoſſible. See therefore *Hakewill's Apolog.* l. 3. c. 6. ſect. 2.

(*w*) Dr.

Uſe of the Magnet (*w*), Printing (*x*), Clocks (*y*), Teleſcopes

(*w*) Dr. *Gilbert*, the moſt learned and accurate Writer on e *Magnet*, ſhews, That its *Attractive* Virtue was known as rly as *Plato* and *Ariſtotle*; but its *Direction* was a Diſcovery later Ages. He ſaith, *Superiori evo* 300 *aut* 400 *labentibus nis, Motus Magneticus in Boream & Auſtrum repertus, aut ab he-nibus rurſus recognitus fuit.* De Mag. l. 1. c. 1. But who the ppy Inventer of this lucky Diſcovery was, is not known. here is ſome, not inconſiderable, Reaſon, to think our fa-ous Countryman, *Rog. Bacon*, either diſcovered, or at leaſt ew of it. But for its Uſe in Navigation, Dr. *Gilbert* ſaith, *regno Neapolitano Melphitani omnium primi (uti ferunt) pyxidem truebant nauticam. ——edocti à cive quodam Fol. Goia*, A. D. 00, ibid. If the Reader hath a mind to ſee the Argu-nts for the Invention, being as old as *Solomon*'s or *Plautus*'s me, or of much younger Date, he may conſult *Hakewill*, c. 10. *ſect.* 4. or *Purchas Pilgr. l.* 1. *c.* 1. *ſect.* 1.

As to the Magnetick Variation, Dr. *Gilbert* attributes the ſcovery of it to *Sebaſtian Cabott*. And the Inclination, of pping of the Needle, was the Diſcovery of our ingenious . *Norman*. And laſtly, The Variation of the Variation, s firſt found out by the ingenious Mr. *H. Gellibrand*, Aſtr. of. of *Greſham-Col.* about 1634. *Vid. Gellibr. Diſc. Math. on Variation of the Mag. Need. and its Variat.* Anno 1635.

But ſince that, the before-commended Dr. *Halley*, having rmerly, in *Philoſ. Tranſ.* No. 148, and 195, given a proba-e Hypotheſis of the Variation of the Compaſs, did in the ear 1700, undertake a long and hazardous Voyage, as far as e Ice near the South Pole, in order to examine his ſaid Hy-theſis, and to make a Syſtem of the Magnetical Variations: hich being ſoon after publiſhed, has been ſince abundantly nfirmed by the *French*, as may be ſeen in ſeveral of the late *emoirs de Phyſique & de Mathematique*, publiſh'd by the French *ademie des Sciences*.

To theſe Diſcoveries, I hope the Reader will excuſe me, I add one of my own, which I deduced ſome Years ago, m ſome magnetical Experiments and Obſervations I made; hich Diſcovery I alſo acquainted our Royal Society with me time ſince, *viz.* That as the common, horizontal Nee-e is continually varying up and down, towards the E. and . ſo is the Dipping-Needle varying up and down, towards fromwards with the Zenith, with its Magnetick Tenden-, deſcribing a Circle round the Pole of the World, as I nceive, or ſome other Point. So that if we could procure a Needle

Teleſcopes (*z*), and an hundred Things beſide ſhould eſcape the Diſcovery of *Archimedes*, *naximander*

a Needle ſo nicely made, as to point exactly according to Magnetick Direction, it would, in ſome certain Number Years, deſcribe a Circle, of about 13 *gr.* Radius round Magnetick Poles Northerly and Southerly. This I have ſeveral Years ſuſpected, and have had ſome Reaſons for too, which I mentioned three or four Years ago at a Meeti of our *Royal Society*; but I have not yet been ſo happy procure a tolerable good Dipping-Needle, or other prop one to my Mind, to bring the Thing to ſufficient Teſt of Ex perience; as in a ſhort Time I hope to do, having lately hi upon a Contrivance that may do the Thing.

(*x*) It is uncertain who was the Inventer of the Art *Printing*, every Hiſtorian aſcribing the Honour thereof to h own City or Country. Accordingly, ſome aſcribe the Inve tion of it to *John Guttenburg*, a Knight of *Argentine*, abo 1440, and ſay, that *Fauſtus* was only his Aſſiſtant. Bert aſcribes it to *Laurence John*, of *Haerlem*, and ſaith, *Fuſt Fauſt*, ſtole from him both his Art and Tools. And to nam no more, ſome attribute it to *John Fuſt* or *Fauſt*, and Pe *Schoeffer* (called by *Fuſt*, in ſome of his *Imprimaturs*, *Pet. de Ge neſhem puer meus.*) But there is now to be ſeen at *Haerlem*, Book or two printed by *Lau. Koſter*, before any of theſe, v in 1430, and in 1432. (*See Mr.* Ellis's *Letter to Dr.* Tyſon, *Phil. Tranſ.* No. 286.) But be the firſt Inventer who it w there is however great Reaſon to believe, the Art recei great Improvements from *Fauſt*, and his Son-in-Law *Schoeff* the latter being the Inventer of metalline Types, which we cut in Wood before, firſt in whole Blocks, and afterwards ſingle Types or Letters. See my learned Friend Mr. *W ley's* Obſervations, in *Philoſ. Tranſ.* No. 288, and 310.

(*y*) Concerning the Antiquity and Invention of *Clocks* a *Clock-Work*, I refer the Reader to a little Book, called t *Artificial Clock-Maker*, Chap. 6. Where there is ſome Accou of the Ancients Inventions in Clock-Work, as *Archime Sphere*, *Creſibius's Clock*, &c.

(*z*) The Invention of *Teleſcopes*, *Hieron. Syrturus* gives t Account of, *Prodiit* Anno 1609, *Seu Genius, ſeu alter vir a incognitus, Hollandi ſpecie, qui Middleburgi in Zelandiâ convenit J Lipperſein——Juſſit perſpicilla plura tam cava quam convexa, con Conditio die rediit, abſolutum opus cupiens, atque ut ſtatim habuit manibus, bina ſuſcipiens, cavum ſcil. & convexum, unum & alter*

aximander, Anaximenes, Poſidonius, or other cat Virtuoſo's of the early Ages, whoſe Contri-nces of various Engines, Spheres, Clepſydræ, and her curious Inſtruments are recorded (*aa*)? And why

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o admovebat, & ſenſim dimovebat ſive ut punctum concurſûs, ſive rtificis opus probaret, poſtea abiit. Artifex, ingenii minimè expers, novitatis curioſus cœpit idem facere & imitari, &c. Vid. Muſ. rm. l. 4. c. 7.

aa) Among the curious Inventions of the Ancients, *Archy-s Dove* was much famed; of which *Aul. Gellius* gives this count: *Scripſerunt Simulachrum Columbæ è ligno ab Archytâ ra-quâdam diſciplinâque mechanicâ factum, volâſſe: Ita erat ſcilicet mentis ſuſpenſum, & aurâ ſpiritûs incluſâ atque occultâ concitum.* t. Attic. l. 10. c. 12. The ſame eminent *Pythagoræan* loſopher (as *Favorinus* in *Gellius* calls him) is by *Horace* ac-nted a noble Geometrician too, *Te maris & terræ, numero-carentis arenæ Menſorem Archyta.* Among the reſt of his entions, *Children's Rattles* are aſcribed to him. *Ariſtotle* calls m Ἀρχύτε πλαταγὴ, *Polit.* 8. i. e. *Archytas*'s *Rattle.* And *genianus*, the Grammarian, gives the Reaſon of his Inven-n, Ἀρχύτε πλαταγὴ ἐπὶ τῶν, &c. *That* Archytas's Rattle *to quiet Children; for he having Children, contrived the Rattle, ch he gave them to prevent their* [*tumbling,* διαταλεύεσθαι] *other ngs about the Houſe.*

To theſe Contrivances of *Archytas*, we may add *Regiomon-us's Wooden Eagle, which flew forth of the City aloft in the Air, the Emperor a good Way off, coming towards it, and having ſaluted , return'd again, waiting on him to the City-Gates.* Alſo his *-Fly*, which at a Feaſt *flew forth of his Hands, and taking a nd, returned thither again.* Vid. *Hakewill*, ub. ſupr. c. 10. t. 1.

As to other Inventions of the Ancients, ſuch as of Let-s, Brick and Tiles, and building Houſes, with the Saw, le, and Plumber, the Lath, Augre, Glue, &c. alſo the king Braſs, Gold, and other Metals; the uſe of Shields, ords, Bows and Arrows, Boots, and other Inſtruments War; the Pipe, Harp, and other Muſical Inſtruments; building of Ships and Navigation, and many other ings beſides; the Inventers of theſe (as reported by An-nt Heathen Authors) may be plentifully met with in *Plin. t. Hiſt. l.* 7. *c.* 56.

But

why cannot the preſent or paſt Age, ſo eminent for polite Literature, for Diſcoveries and Improvements in all curious Arts and Buſineſſes (perhaps beyond any known Age of the World; why cannot it, I ſay) diſcover thoſe hidden *Quæſita*, which may probably be reſerved for the Diſcovery of future and leſs learned Generations?

Of theſe Matters, no ſatisfactory Account can be given by any mechanical Hypotheſis, or any other Way, without taking in the Superintendence of the Great Creator and Ruler of the World; who oftentimes doth manifeſt himſelf in ſome of the moſt conſiderable of thoſe Works of Men, by ſome remarkable Tranſactions of his Providence, or by ſome great Revolution or other happening in the World thereupon. Of this I might inſtance

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But in this Account of *Pliny* we may obſerve whence the Ancients (even the *Romans* themſelves in ſome meaſure) had their Accounts of theſe Matters, *viz.* from the fabulous *Greeks*, who were fond of aſcribing every Thing to themſelves. *The Truth is* (ſaith the moſt learned Biſhop *Stillingfleet*) *there is nothing in the World uſeful or beneficial to Mankind, but they have made a ſhift to find the Author of it among themſelves. If we enquire after the Original of* Agriculture, *we are told of* Ceres *and* Triptolemus; *if of* Paſturage, *we are told of an* Arcadian Pan; *if of* Wine, *we preſently hear of a* Liber Pater; *if of* Iron *Inſtruments, then who but* Vulcan; *if of* Muſick, *none like to* Apollo. *If we preſs them then with the Hiſtory of other Nations, they are as well provided here; if we enquire an Account of* Europe, Aſia, *or* Libya; *for the firſt, we are told a fine Story of* Cadmus's *Siſter; for the ſecond,* Prometheus's *Mother of that Name; and for the third, of a Daughter of* Epaphus. And ſo the learned Author goes on with other particular Nations, which they boaſted themſelves to be the Founders of. *Only the grave* Athenians *thought Scorn to have any Father aſſigned them, their only Ambition was to be accounted* Aborigines & genuini Terræ. But the Ignorance and Vanity of the *Greek* Hiſtory, that learned Author hath ſufficiently refuted. *Vid.* Stilling. *Orig. Sacr. Part* 1. *B.* 1. *C.* 4.

(hh) Whe-

nce in the Invention of Printing (*bb*), ſucceed- firſt by a train of Learned Men, and the Revi- l of Learning, and ſoon after that by the Refor- ation, and the much greater Improvements of arning at this Day. But the moſt conſiderable ſtance I can give is, the Progreſs of Chriſtianity, means of the civilized Diſpoſition, and large tent of the *Roman Empire*. The latter of hich, as it made way for Human Power; ſo the rmer made way for our moſt excellent Religion o the Minds of Men. And ſo I hope, and ear- ſtly pray, That the Omnipotent and All-wiſe uler of the World will tranſact the Affairs of r moſt Holy Religion, e'er it be long, in the Hea- en World; that the great Improvements made the laſt, and preſent Age, in Arts and Sciences, Navigation and Commerce, may be a Means tranſport our Religion, as well as Name, through l the Nations of the Earth. For we find that r Culture of the more polite and curious Scien- s, and our great Improvements in even the Me- anick Arts, have already made a Way for us to ſome of the largeſt and fartheſt diſtant Nati- ns of the Earth; particularly into the great Em- re of *China* (*cc*). And

(*bb*) Whether *Printing* was invented in 1440, as many agine, or was ſooner practiſed, in 1430, or 1432, as r. *Ellis*'s Account of the *Dutch* Inſcription in *Phil. Tranſ.* o. 286. doth import; it is however manifeſt, how great Influence (as it was natural) this Invention had in the romoting of Learning ſoon afterwards, mentioned before *Note* (*x*). After which followed the Reformation about e Year 1517.

(*cc*) The *Chineſe* being much addicted to Judicial Aſtro- gy, are great Obſervers of the Heavens, and the Appearan- es in them. For which Purpoſe they have an *Obſervatory*

at

And now, before I quit this Subject, I cannot but make one Remark, by way of practical Inference, from what has been laſt ſaid; and that is, Since it appears that the Souls of Men are ordered, diſpoſed and actuated by God, even in ſecular, as well as ſpiritual Chriſtian Acts; a Duty ariſeth thence on every Man, to purſue the Ends, and anſwer all the Deſigns of the Divine Providence, in beſtowing his Gifts and Graces upon him. Men are ready to imagine their Wit, Learning, Genius, Riches, Authority, and ſuch like, to be Works of Nature, Things of Courſe, or owing to their own Diligence, Subtilty, or ſome Secondary Cauſes; that they are Maſters of them, and at Liberty to uſe them as they pleaſe, to gratifie their Luſt or Humour, and ſatisfie their depraved Appetites. But it is evident, That theſe Things are the Gifts of God, they are ſo many Talents entruſted with us by the Infinite Lord of the World, a Stewardſhip, a Truſt repoſed in us; for which we muſt give an Account at the Day when our Lord ſhall call;

at *Pekin*, and five Mathematicians appointed to watch every Night; four towards the four Quarters of the World, and one towards the Zenith, that nothing may eſcape their Obſervation. Which Obſervations are the next Morning brought to an Office to be regiſtred. But notwithſtanding this their Diligence for many Ages, and that the Emperor hath kept in his Service above 100 Perſons to regulate the Kalendar, yet are they ſuch mean Aſtronomers, that they owe the Regulation of their Kalendar, the Exactneſs in calculating Eclipſes, &c. to the *Europeans*; which renders the *European* Mathematicians ſo acceptable to the Emperor, that Father *Verbieſt*, and divers others, were not only made Principals in the Obſervatory, but put into Places of great Truſt in the Empire, and had the greateſt Honours paid them at their Deaths. *Vid. La Comte Mem. of China.* Letter 2d. &c.

(*dd*) 1 Tim.

ll; according to the parabolical Repreſentation f this Matter by our Bleſſed Saviour. *Matt.* xv. 14.

Our Duty then is not to abuſe theſe Gifts of od, *not to neglect the Gift that is in us*, not to *ide our Talent in the Earth*; but as St. *Paul* horteth *Timothy*, 2 *Tim.* i. 6. we muſt *ſtir up he Gift of God which is in us*, and not let it lie le, concealed or dead; but we muſt ἀναζωπυρεῖν τὸ χάρισμα, *blow it up, and enkindle it*, as the Original imports; we muſt improve and employ our ift to the Glory of the Giver; or in that Miniſtration, that Uſe and Service of the World, for which e gave it. Our Stewardſhip, our Craft, our Calng, be it that of Ambaſſadors of Heaven, committd to us, as 'twas to *Timothy*, (*dd*) by the laying n of Hands; or be it the more ſecular Buſineſs of he Gentleman, Tradeſman, Mechanick, or only ervant; nay, our good Genius, our Propenſity to ny Good, as ſuppoſe to Hiſtory, Mathematicks, Botany, Natural Philoſophy, Mechanicks, *&c.* I ay, all theſe Occupations, in which the Providence f God hath engaged Men, all the Inclinations to which his Spirit hath diſpoſed them, ought to be iſcharged with that Diligence, that Care and Fidelity, that our Great Lord and Maſter may not ſay o us, as was ſaid to the unfaithful Steward, *Luke* xvi. 2. *Give an Account of thy Stewardſhip, for hou mayeſt be no longer Steward*; but that he may ſay, as 'tis in the Parable before-cited, *Matt.* xxv. 21. *Well done thou good and faithful Servant, thou haſt been faithful over a few Things, I will*

(*dd*) 1 Tim. iv. 14. 2 Tim. i. 6. (*ee*) Biſhop

I will make thee Ruler over many Things, enter thou into the Joy of thy Lord. Since now the Case is thus, let us be perswaded to follow *Solomon's* Advice, *Eccles.* ix. 10. *Whatsoever thy Hand findeth to do, do it with thy Might* (ee). "Lay hold on every Occasion that presents it self, "and improve it with the utmost Diligence; because now is the Time of Action, both in the "Employments of the Body, and of the Mind; "now is the Season of studying either Arts and "Sciences, or Wisdom and Virtue, for which thou "wilt have no Opportunities in the Place whither "thou art going in the other World. *For there "is no Work, nor Device, nor Knowledge, nor "Wisdom in the Grave whither thou goest.*

(ee) Bishop *Patrick* in loc.

CHAP. II.

Of Man's Body, particularly its Posture.

HAving thus, as briefly as well I could, surveyed the *Soul*, let us next take a View of *Man's Body.* Now here we have such a Multiplicity of the most exquisite Workmanship, and of the best Contrivance, that if we should strictly Survey the Body from Head to Foot, and search only into the known Parts (and many more lie undiscovered) we should find too large and tedious a Task to be dispatched. I shall therefore have Time only to take a transient and general Kind of View of this admirable Machine, and that somewhat briefly too, being

eing prevented by others, particularly two excel-nt Authors of our own (*a*), who have done it on he ſame Account as my ſelf. And the

I. Thing that preſents it ſelf to our View, is the *Erect Poſture* (*b*) of Man's Body; which is far the oſt, if not the only commodious Poſture for a ational Creature, for him that hath Dominion er the other Creatures, for one that can invent eful Things, and practiſe curious Arts. For ithout this erect Poſture, he could not have adily turned himſelf to every Buſineſs, and on very Occaſion. His Hand (*c*) particularly could not

(*a*) *Mr.* Ray, *in his Wiſdom of God manifeſted in the Works of reation*, Part 2. And *Dr.* Cockburn's *Eſſays on Faith*, Part 1. ſſay 5.

(*b*) *Ad hanc providentiam Naturæ tam diligentem* [of which he d been before ſpeaking] *tamque ſolertem adjungi multa poſſunt, quibus intelligatur, quantæ res hominibus à Deo, quamque eximiæ ibutæ ſunt: qui primùm eos humo excitatos, celſos & erectos conſtituit, Deorum cognitionem, cœlum intuentes, capere poſſunt. Sunt enim è rrâ homines non ut incolæ, atque habitatores, ſed quaſi ſpectatores ſurarum rerum, atque cœleſtium, quarum ſpectaculum ad nullum aliud nus animantium pertinet.* Cic. de Nat. Deor. l. 2. c. 56.

(*c*) *Ut autem ſapientiſſimum animalium eſt Homo, ſic & Manus nt organa ſapienti animali convenientia. Nam enim quia Manus abuit, propterea eſt ſapientiſſimum, ut Anaxagoras dicebat; ſed quia pientiſſimum erat, propter hoc Manus habuit, ut rectiſſimè cenſuit riſtoteles. Non enim Manus ipſæ hominem artes docuerunt, ſed Ra-. Manus autem ipſæ ſunt artium organa, &c.* Galen. de Uſ. art. l. 1. c. 3. After which, in the reſt of this firſt Book, nd Part of the ſecond, he conſiders the Particulars of the *Hand*, in order to enquire, as he ſaith, *Ch.* 5. *Num eam omnino onſtitutionem habeat* [manus] *quiâ meliorem aliam habere non potuit.* Of this Part, (and indeed of the other Parts of Human Bodies) he gives ſo good an Account, that I confeſs I could ot but admire the Skill of that ingenious and famed Heathen. For an Example, (becauſe it is a little out of the Way,) I ſhall pitch upon his Account of the different Length f the Fingers. *Lib.* 1. *Cap.* 24. The Reaſon of this Mecha-

not have been in ſo great a Readineſs to execute the Commands of the Will, and Dictates of the Soul. His Eyes would have been the moſt prone and incommodiouſly ſituated of all Animals; but by this Situation, he can caſt his Eyes upwards, downwards, and round about him; he hath the Glorious Hemiſphere of the Heavens (*d*), and an ample Horizon on Earth (*e*), to entertain his Eye. And

niſm, he ſaith is, That the Tops of the Fingers may come to an Equality, *Cùm magnas aliquas moles in circuitu comprehendunt; & cùm in ſeipſis humidum vel parvum corpus continere conantur. ——Apparent verò in unam circuli circumferentiam convenire Digiti quinque in actionibus hujuſmodi maximè quando exquiſitè ſphæricum corpus comprehendunt.* And this Evenneſs of the Fingers Ends, in graſping ſphærical, and other round Bodies, he truly enough ſaith, makes the Hold the firmer. And it ſeems a noble and pious Deſign he had in ſo ſtrictly ſurveying the Parts of Man's Body, which take in his own tranſlated Words, *Cùm multa namque eſſet apud vetres, tam Medicos, quam Philoſophos de utilitate particularum diſſenſio (quidam enim corpora noſtra nullius gratiâ eſſe facta exiſtimant, nullâque omnino arte; alii autem & alicujus gratiâ, & artificioſè,——) primum quidem tantæ hujus diſſenſionis* αὐτόπτης *invenire ſtudui: deinde verò & unam aliquam univerſalem methodum conſtituere, quâ ſingularum partium corporis, & eorum quæ illis accidunt utilitatem invenire poſſemus.* Ibid. cap. 8.

(*d*) *Pronaque cum ſpectant animalia cætera terram,*
Os Homini ſublime dedit, cœlumque tueri
Juſſit, & erectos ad ſidera tollere vultus.
Ovid. Metam. l. 1. car. 84.

(*e*) If any ſhould be ſo curious, to deſire to know how far a Man's Proſpect reacheth, by Means of the Height of his Eye, ſuppoſing the Earth was an uninterrupted Globe; the Method is a common Caſe of right-angled plain Triangles, where two Sides, and an oppoſite Angle are given: Thus in *Fig.* 4. *A H B* is the Surface, or a great Circle of the Terraqueous Globe; *C* the Center, *H C* its Semidiameter, *E* the *Height* of the Eye; and foraſmuch as *H E* is a Tangent, therefore the Angle at *H* is a right Angle: So that there are given *H C* 398,386 Miles, or 21034781 *Engliſh* Feet, (according to *Book* II. *Chap.* 2. *Note* (*a*);) *C E* the ſame

ame Length with the Height of the Eye, on the Maſt of a hip, or at only a Man's Height, &c. added to it; and *EHC* he oppoſite Right Angle. By which three Parts given, it eaſy to find all the other Parts of the Triangle. And rſt, The Angle at *C*, in order to find the Side *HE*, the roportion is, as the Side *CE*, to the Angle at *H*; ſo the ide *HC*, to the Angle at *E*, which being ſubſtracted out of 0 gr. the Remainder is the Angle at *C*. And then, as the ngle at *E*, is to its oppoſite Side *HC*, or elſe as the Angle *H* is to its oppoſite Side *CE*; ſo the Angle at *C*, to its ppoſite Side *EH*, the viſible Horizon. Or the Labour ay be ſhortned, by adding together the Logarithm of the um of the two given Sides, and the Logarithm of their ifference; the Half of which two Logarithms, is the Lo-arithm of the Side requir'd, nearly. For an Example, e will take the two Sides in Yards, by Reaſon ſcarce y Table of Logarithms will ſerve us farther. The Se-idiameter of the Earth is 7011594 Yards; the Height the Eye is two Yards more, the Sum of both Sides, is 4023190.

Logar. of which Sum is, — — —	7,1468468
Logar. of two Yards (the Difference) is,	0,3010300
Sum of both Logar. — — — —	7,4478768
The half Sum, — — — — —	3,7239384

the Logarithm of 5296 Yards = three Miles, which is the ength of the Line *EH*, or Diſtance the Eye can reach at x Feet High.

This would be the Diſtance, on a perfect Globe, did the iſual Rays come to the Eye in a ſtrait Line; but by Means f the Rarefractions of the Atmoſphere, diſtant Objects on he Horizon, appear higher than really they are, and may e ſeen at a greater Diſtance, eſpecially on the Sea; which a Matter of great Uſe, eſpecially to diſcover at Sea the Land, Rocks, &c. and it is a great Act of the Divine Pro-idence, in the Contrivance and Convenience of the Atmo-phere, which by this Means enlargeth the viſible Horizon, nd is all one, as if the Terraqueous Globe was much larger han really it is. As to the Height of the Apparent above he true Level; or, how much diſtant Objects are raiſed by he Refractions, the ingenious and accurate Gentlemen of he *French Academy Royal*, have given us a Table in their *Meaſure of the Earth*, Art. 12.

And as this Erection of Man's Body is the moſt compleat Poſture for him; ſo if we Survey the Proviſion made for it, we find all done with manifeſt Deſign, the utmoſt Art and Skill being employ'd therein. To paſs by the particular Conformation of many of the Parts, the Ligaments and Faſtnings to anſwer this Poſture; as the Faſtning, for Inſtance, of the *Pericordium* to the *Diaphragm*, (which is peculiar to Man (*f*); I ſay, paſſing by a deal of this Nature, manifeſting this Poſture to be an Act of Deſign,) let us ſtop a little at the curious Fabrick of the Bones, thoſe Pillars of the Body. And how artificially do we find them made, how curiouſly plac'd from the Head to Foot! The *Vertebræ* of the Neck and Back-bone (*g*), made ſhort and complanated, and firmly braced with Muſcles and Tendons, for eaſy Incurvations of the Body; but withal for greater Strength, to ſupport the Body's own Weight, together with other additional Weights it may have Occaſion to bear. The *Thigh-bones* and Legs long, and ſtrong, and every Way well fitted for the Motion of the Body. The *Feet* accommodated with a great *Number of Bones*, curiouſly and firmly tack'd together, (to which muſt be added the Miniſtry of the Muſcles (*h*), to anſwer

(*f*) See *Book* VI. *Chap.* 5. *Note* (*g*).

(*g*) See *Book* IV. *Chap.* 8. *Note* (*c*).

(*h*) The Mechaniſm of the Foot, would appear to be wonderful, if I ſhould deſcend to a Deſcription of all its Parts; but that would be too long for theſe Notes; therefore a brief Account, (moſt of which I owe to the before-commended Mr. *Cheſelden*,) may ſerve for a Sample: In the firſt Place, it is neceſſary the Foot ſhould be concave, to enable us to ſtand firm, and that the Nerves and Blood-Veſſels may be free from Compreſſion when we ſtand or wal

ſwer all the Motions of the Legs and Thighs, and at the ſame Time to keep the Body upright, and prevent its falling, by readily aſſiſting againſt every Vacillation thereof, and with eaſy and ready Touches keeping the *Line of Innexion*, and *Centre of Gravity*, in due Place and Poſture (*i*).

And as the Bones are admirably adapted to prop; ſo all the Parts of the Body are as incomparably plac'd to poiſe it. Not one Side too heavy for the other; but all in nice Æquipoiſe: The Shoulders, Arms, and Side æquilibrated on one Part; on the other Part the *Viſcera* of the Belly counterpois'd with the Weight of the ſcapular Part, and that uſeful Cuſhion of Fleſh behind.

And laſtly, To all this we may add the wonderful Concurrence, and Miniſtry, of the prodigious Number and Variety of Muſcles, plac'd throughout the Body for this Service; that they ſhould ſo readily

walk. In order hereunto, the long *Flexors* of the Toes croſs one another at the Bottom of the Foot, in the Form of a St. *Andrew*'s Croſs, to incline the leſſer Toes towards the great One, and the great One towards the leſſer. The *ſhort Flexors* are chiefly concern'd in drawing the Toes towards the Heel. The *tranſverſalis Pedis* draws the Outſides of the Foot towards each other; and by being inſerted into one of the *ſeſamoid* Bones of the great Toe, diverts the Power of the *abductor Muſcle*, falſly ſo called, and makes it become a *Flexor*. And laſtly, The *peronæus Longus* runs round the outer Ankle, and obliquely forwards croſs the Bottom of the Foot, and at once helps to extend the *Tarſus*, to conſtrict the Foot, and to direct the Power of the other *Extenſors* towards the Ball of the great Toe: Hence the Loſs of the great Toe, is more than of all the other Toes. See alſo Mr. *Cowper*'s *Anat.* Tab. 28, &c.

(*i*) It is very well worth while to compare here what *Borelli* ſaith, *de motu Animal.* Par. 1. cap. 18. *De ſtatione Animal.* Prop. 132, &c. To which I refer the Reader, it being too long to recite here.

readily anſwer to every Poſture; and comply with every Motion thereof, without any previous Thought or Reflex act, ſo that (as the excellent *Borelli* (*k*) ſaith, "It is worthy of Admiration, that in ſo "great a Variety of Motions, as Running, Leap- "ing, and Dancing, Nature's Laws of Æqualibra- "tion ſhould always be obſerved; and when ne- "glected, or wilfully tranſgreſſed, that the Body "muſt neceſſarily and immediately tumble down,

(*k*) Borel. ibid. Prop. 142.

CHAP. III.

Of the Figure and Shape of Man's Body.

THE Figure and Shape of Man's Body, is the moſt commodious that could poſſibly be invented for ſuch an Animal; the moſt agreeable to his Motion, to his Labours, and all his Occaſions. For had he been a rational Reptile, he could not have moved from Place to Place faſt enough for his Buſineſs, nor indeed have done any almoſt. Had he been a rational Quadrupede, among other Things, he had loſt the Benefit of his Hands, thoſe noble Inſtruments of the moſt uſeful Performances of the Body. Had he been made a Bird, beſides many other great Inconveniencies, thoſe before-mentioned of his Flying would have been ſome. In a Word, any other Shape of Body, but that which the All-wiſe Creator hath given Man, would have been as incommodious, as any Poſture but that of erect; it would have rendered him more Helpleſs, or have put

put it in his Power to have been more Pernicious, or deprived him of Ten-thouſand Benefits, or Pleaſures, or Conveniences, which his preſent Figure capacitates him for.

CHAP. IV.

Of the Stature and Size of Man's Body.

AS in the Figure, ſo in the Stature and Size of Man's Body, we have another manifeſt Indication of excellent Deſign. Not too Pygmean (*a*), not too Gigantick (*b*), either of which Sizes would in ſome Particular or other, have been incommodious to Himſelf, or to his Buſineſs, or to the reſt of his Fellow-Creatures. Too Pygmean would have rendered him too puny a Lord of the Creation; too impotent, and unfit to manage the inferiour Creatures; would have expoſed him to the Aſſaults of the weakeſt Animals, to the ravening Appetite of voracious Birds, and have put him in the Way, and endangered his being trodden in the Dirt by the larger Animals. He would have been alſo too weak for his Buſineſs, unable to carry Burdens; and in a Word, to tranſact the greater Part of his Labours and Concerns. And

(*a*) What is here urged about the Size of Man's Body, may anſwer one of *Lucretius*'s Reaſons, why *Nil ex nihilo gignitur.* His Argument is,

Denique cur Homines tantos natura parare
Non potuit, pedibus qui pontum per vada poſſent
Tranſire, & magnos manibus divellere montes?

Lucret. l. 1. carm. 200.

(*b*) *Haud facile fit ut quiſquam & ingentes corporis vires, & ingenium ſubtile habeat,* Diodor. Sic. l. 17.

And on the other Hand, had Man's Body been made too monſtrouſly ſtrong, too enormouſly Gigantick (*c*), it would have rendered him a dangerous

(*c*) Altho' we read of *Giants* before *Noah*'s Flood, *Gen.* vi. 4. and more plainly afterwards in *Numb.* xiii. 33. Yet there is great Reaſon to think the Size of Man was always the ſame from the Creation. For as to the *Nephilim*, or *Giants*, in *Gen.* vi. the Ancients vary about them; ſome taking them for great *Atheiſts*, and Monſters of Impiety, Rapine, Tyranny, and all Wickedneſs, as well as of monſtrous Stature, according as indeed the *Hebrew* Signification allows.

And as for the *Nephilim*, in *Numb.* xiii. which were evidently Men of a Gigantick Size, it muſt be conſidered, that it is very probable, the Fears and Diſcontentments of the Spies might add ſomewhat thereunto.

But be the Matter as it will, it is very manifeſt, that in both theſe Places, *Giants* are ſpoken of as Rarities, and Wonders of the Age, not of the common Stature. And ſuch Inſtances we have had in all Ages; excepting ſome fabulous Relations; ſuch as I take to be that of *Theutobocchus*, who is ſaid to have been dug up, *Anno* 1613, and to have been higher than the Trophies, and 26 Feet long; and no better I ſuppoſe the Giants to have been that *Ol. Magnus* gives an Account of in his 5th Book, ſuch as *Harthen*, and *Starchater*, among the Men; and among the Women, *Reperta eſt* (ſaith he) *puella—in capite vulnerata, ac mortua, induta chlamyde purpureâ, longitudinis cubitorum* 50, *latitudinis inter humeros quatuor.* Ol. Mag. Hiſt. l. 5. c. 2.

But as for the more credible Relations of *Goliath* (*whoſe Height was 6 Cubits and a Span*, 1 Sam. xvii. 4. which according to the late curious and learned Lord Biſhop of *Peterborough*, is ſomewhat above 11 Feet *Engliſh*, *vid.* Biſhop *Cumberland of* Jewiſh *Weights and Meaſures*) of *Maximinus* the Emperor, who was 9 Feet high, and others in *Auguſtus*, and other Reigns, of about the ſame Height: To which we may add, the Dimenſions of a *Skeleton*, dug up lately in the Place of a *Roman* Camp near St. *Albans*, by an Urn, inſcribed, *Marcus Antoninus*; of which an Account is given by Mr. *Cheſelden*, who judgeth by the Dimenſions of the Bones, that the Perſon was 8 Feet high. *Vid. Philoſ. Tranſ.* No. 333. Theſe antique Examples and Relations, I ſay, we can match, yea, out-do, with modern Examples; of which we have divers in *J. Ludolph. Comment. in Hiſt. Æthiop. l.* 1. *c.* 2. *ſect.* 22. *Magus*,

Magus, *Conringius*, Dr. *Hakewill*, and others. Which latter relates from *Nannez*, of Porters and Archers belonging to the Emperor of *China*, of 15 Feet high; and others from *Purchas*, of 10 and 12 Feet high, and more. See the learned Author's *Apolog. p.* 208.

These indeed exceed what I have seen in *England*; but in 1684, I my self measur'd an *Iriſh* Youth, ſaid to be not 19 Years old, who was 7 Feet near 8 Inches; and in 1697, a Woman who was 7 Feet 3 Inches in Height.

But for the ordinary Size of Mankind, in all Probability, it was always (as I ſaid) the ſame, as may appear from the Monuments, Mummies, and other ancient Evidences to be ſeen at this Day. The moſt ancient Monument at this Day, I preſume, is that of *Cheops*, in the firſt and faireſt Pyramid of *Ægypt*; which was, no doubt, made of Capacity every Way ſufficient to hold the Body of ſo great a Perſon as was intended to be laid up in it. But this we find, by the nice Meaſures of our curious Mr. *Greaves*, hardly to exceed our common Coffins. *The hollow Part within* (ſaith he) *is in Length* only 6,488 *Feet*, and *in Breadth* but 2,218 *Feet: The Depth* 2,860 *Feet. A narrow Space, yet large enough to contain a moſt potent and dreadful Monarch, being dead; to whom living, all* Ægypt *was too weight and narrow a Circuit. By theſe Dimenſions, and by ſuch other Obſervations, as have been taken by me from ſeveral embalmed Bodies in* Ægypt, *we may conclude there is no decay in Nature* (*though the Queſtion is as old as* Homer,) *but that the Men of this Age are of the ſame Stature they were near* 3000 *Years ago.* Vid. *Greaves* of the Pyr. in 1638, in *Ray*'s Collect. of *Trav.* Tom. 1. p. 118.

To this more ancient, we may add others of a later Date. Of which take theſe, among others, from the curious and learned *Hakewill*. The Tombs at *Piſa*, that are ſome thouſand Years old, are not longer than ours; ſo is *Athelſtane*'s in *Malmesbury*-Church; ſo *Sebba*'s in St. *Paul*'s, of the Year 693; *Etheldred*'s, &c. Apol. 216, *&c.*

The ſame Evidence we have alſo from the Armour, Shields, Veſſels, and other Utenſils dug up at this Day. The Braſs Helmet dug up at *Metaurum*, which was not doubted to have been left there at the *Overthrow of Aſdrubal*, will fit one of our Men at this Day.

Nay, beſides all this, probably we have ſome more certain Evidence. *Auguſtus* was 5 Feet 9 Inches high, which was the juſt Meaſure of our famous Queen *Elizabeth*, who exceed his Height 2 Inches, if proper Allowance be made for the Difference between the *Roman* and our Foot. *Vid.* Hakew. *ib. p.* 215.

(*d*) To

rous Tyrant in the World, too ſtrong (*d*) in ſome Reſpects, even for his own Kind, as well as the other Creatures. Locks and Doors might per-

hap

(*d*) To the Stature of Men in the foregoing Note, we may add ſome Remarks about their unuſual *Strength*. That of *Sampſon* (who is not ſaid to have exceeded other Men in Stature, as he did in Strength) is well known. So of old *Hector*, *Diomedes*, *Hercules*, and *Ajax*, are famed; and ſince them many others; for which I ſhall ſeek no farther than the before-commended *Hakewill*, who by his great and curious Learning, hath often moſt of the Examples that are to be met with on all his Subjects he undertakes. Of the After-Ages he names *C. Marius*, *Maximinus*, *Aurelian*, *Scanderberge*, *Bardeſin*, *Tamerlane*, *Siska*, and *Huniades*. Anno 152[illegible] *Kluniber*, Provoſt of the great Church at *Miſnia*, carry'd a Pipe of Wine out of the Cellar, and laid it in the Cart. *Mayolus* ſaw one hold a Marble Pillar in his Hand 3 Feet long, and 1 Foot diameter, which he toſs'd up in the Air and catched again, as if it were a Ball. Another of *Mantua* and a little Man, named *Rodamas*, could break a Cable, &c. *Ernando Burg*, fetched up Stairs an Aſs laden with Wood and threw both into the Fire. At *Conſtantinople*, *Anno* 158[illegible] one lifted a Piece of Wood, that twelve Men could ſcarce raiſe; then lying along, he bare a Stone that ten Men could but juſt roll to him. *G.* of *Fronsberge*, Baron *Mindlehaim*, could raiſe a Man off his Seat, with only his middle Finger; ſtop an Horſe in his full Career; and ſhove a Cannon out of its Place. *Cardan* ſaw a Man dance with two Men in his Arms, two on his Shoulders, and one on his Neck. *Patacoua*, Captain of the *Coſſacks*, could tear an Horſe-Shoe (and if I miſtake not, the ſame is reported of the preſent King *Auguſtus* of *Poland*.) A Gigantick Woman of the *Netherlands* could lift a Barrel of *Hamburgh* Beer. Mr. *Carew* had a Tenant that could carry a Butt's Length, 6 Buſhels of Wheaten Meal (or 15 Gallons Meaſure) with the Lubber, the Miller of 24 Years of Age, on the top of it. And *J. Roman* of the ſame County could carry the Carcaſs of an Ox. *Vid.* Hakewill, *ib. p.* 238.

Viros aliquot moderna memoria tam à mineralibus, quàm aliis Sarmathiæ & Gothiæ provinciis adducere congruit, tantâ fortitudine præditos, ut quiſque eorum in humeros ſublevatum Equum, vel Bovem maximum, imò vas ferri 600, 800, *aut* 1000 *librarum* (*quale & aliquæ Puellæ levare poſſunt,*) *ad plura ſtadia portaret.* Ol. Mag. ubi ſupr.

(*e*) Grew

aps have been made of ſufficient Strength to have arricaded our Houſes; and Walls, and Ramparts ight perhaps have been made ſtrong enough to ave fenced our Cities. But theſe Things could ot have been without a great and inconvenient xpence of Room, Materials, and ſuch Neceſſa-es, as ſuch vaſt Structures and Uſes would have caſioned; more perhaps than the World could ave afforded to all Ages and Places. But let us ke the Deſcant of a good Naturaliſt and Phyſi-an on the Caſe (*e*). "Had Man been a Dwarf (ſaid he) he had ſcarce been a Reaſonable Crea-ture. For he muſt then have had a Jolt Head; ſo there would not have been Body and Blood enough to ſupply his Brain with Spirits; or he muſt have had a ſmall Head, anſwerable to his Body, and ſo there would not have been Brain enough for his Buſineſs---Or had the Species of Mankind been Gigantick, he could not have been ſo commodiouſly ſupplied with Food. For there would not have been Fleſh enough of the beſt edible Beaſts, to ſerve his Turn. And if Beaſts had been made anſwerably bigger, there would not have been Graſs enough. And ſo he eth on. And a little after, "There would not have been the ſame Uſe and Diſcovery of his Reaſon; in that he would have done many Things by mere Strength, for which he is now put to invent innumerable Engines ---Neither could he have uſed an Horſe, nor divers other Creatures. But being of a middle Bulk, he is fitted to manage and uſe them all. For (ſaith he)

(*e*) Grew's *Coſmol. Sacr. b.* 1. *ch.* 5. *ſect.* 25.

" he) no other Cauſe can be aſſigned, why a Man " was not made five or ten Times bigger, but his " Relation to the reſt of the Univerſe". Thus far our curious Author.

CHAP. V.

Of the Structure of the Parts of Man's Body.

HAving thus taken a View of the Poſture, Shape, and Size of Man's Body, let us in this Chapter ſurvey the Structure of its Parts. But here we have ſo large a Proſpect, that it would be endleſs to proceed upon Particulars. It muſt ſuffice therefore to take Notice, in general only, how artificially every Part of our Body is made. No Botch, no Blunder, no unneceſſary *Apparatus* (or in other Words) no Signs of Chance (*a*); but every Thing curious, orderly, and performed in the ſhorteſt and beſt Method, and adapted to the moſt compendious Uſe. What one Part is there throughout the whole Body, but what is com-

(*a*) It is manifeſtly an Argument of Deſign, That in the Bodies of different Animals, there is an Agreement of the Parts, ſo far as the Occaſions and Offices agree; but a Difference of thoſe, where there is a Difference of theſe. In an Human Body are many Parts agreeing with thoſe of a Dog for Inſtance; but in his Forehead, Fingers, Hand, Inſtruments of Speech, and many other Parts, there are Muſcles, and other Members which are not in a Dog. And ſo contrariwiſe in a Dog, which are not in a Man. If the Reader is minded to ſee what particular Muſcles are in a Man, that are not in a Dog; or in a Dog, that are not in an Human Body, let him conſult the curious and accurate Anatomiſt Dr. *Douglaſs*'s *Myogr. compar.*

(*b*) *Galen*

ompoſed of the fitteſt Matter for that Part; made f the moſt proper Strength and Texture; ſhaped the compleateſt Form; and in a Word, accou-r'd with every Thing neceſſary for its Motion, ffice, Nouriſhment, Guard, and what not! What commodious a Structure and Texture could have een given to the Bones, for Inſtance, to make them m and ſtrong, and withal light, as that which very Bone in the Body hath? Who could have haped them ſo nicely to every Uſe, and adapted hem to every Part, made them of ſuch juſt Lengths, iven them ſuch due Sizes and Shapes, chanelled, ollowed, headed, lubricated, and every other hing miniſtring, in the beſt and moſt compendi-us Manner to their ſeveral Places and Uſes? hat a Glorious Collection and Combination have e alſo of the moſt exquiſite Workmanſhip and ontrivance in the Eye, in the Ear, in the Hand *b*), in the Foot (*c*), in the Lungs, and other Parts lready mention'd? What an Abridgment of Art, what

(*b*) *Galen* having deſcribed the Muſcles, Tendons, and o-her Parts of the Fingers, and their Motions, cries out, *Con-idera igitur etiam hic mirabilem* CREATORIS *ſapientiam!* De Uſ. art. l. 1. c. 18.

(*c*) And not only in the Hand, but in his Account of the oot (*L.* 3.) he frequently takes Notice of what he calls *Ar-em, Providentiam & Sapientiam Conditoris.* As Ch. 13. *An igitur on æquum eſt hic quoque admirari Providentiam Conditoris, qui ad trumque uſum, etſi certè contrarium, exactè convenientes & conſenti-ntes invicem fabricatus eſt totius membri* [tibiæ] *particulas?* And t the end of the Chap. *Quòd ſi omnia quæ ipſarum ſunt partium nente immutaverimus, neque invenerimus poſitionem aliam meliorem uâ quam nunc ſortita ſunt, neque figuram, neque magnitudinem, ne-ue connexionem, neque (ut paucis omnia complectar) aliud quidquam orum, quæ corporibus neceſſariò inſunt, perfectiſſimam pronunciare opor-et, & undique rectè conſtitutam præſentem ejus conſtructionem.* The ike alſo concludes, Ch. 15.

(*d*) *Ai*

what a Variety of Uſes (*d*), hath Nature laid up-on that one Member of the Tongue, the grand In-ſtrument of Taſte, the faithful Judge, the Centinel the Watchman of all our Nouriſhment, the artfu Modulator of our Voice, the neceſſary Servant o Maſtication, Swallowing, Sucking, and a grea deal beſides? But I muſt deſiſt from proceedin upon Particulars, finding I am fallen upon what propos'd to avoid.

And therefore for a Cloſe of this Chapter, ſhall only add Part of a Letter I receiv'd from the before-commended very curious and ingenious Phyſician Dr. *Tancred Robinſon*: *What*, (ſaith he,) *can poſſibly be better contrived for animal Motion and Life, than the quick Circulation of the Blood and Fluids, which run out of Sight in capillary Veſſels, and very minute Ducts, without Impediment*, (*except in ſome Diſeaſes*,) *being all directed to their peculiar Glands and Chanels, for the different Secretion, ſenſible and inſenſible*; *whereof the laſt is far the greateſt in Quantity and Effects, as to Health and Sickneſs, acute Diſtempers frequently ariſing from a Diminution of Tranſpiration, through the cutaneous Chimneys, and ſome chronical Ones from an Augmentation: Whereas, Obſtructions in the Liver, Pancreas, and other Glands, may only cauſe a Schirrus, a Jaundice, an Ague, a Dropſy, or other ſlow Diſeaſes. So an*

(*d*) *At enim Opificis induſtrii maximum eſt indicium* (*quemadmodum antè ſæpenumerò jam diximus*) *iis quæ ad alium uſum fuerunt comparata, ad alias quoque utilitates abuti, neque laborare ut ſingulis utilitatibus ſingulas faciat proprias particulas.* Galen. ub. ſupr. l. 9. c. 5.

Increaſe

ncreaſe of that Secretion may accompany the eneral Colloquations, as in Fluxes, hectick weats and Coughs, Diabetes, and other Con-mptions. What a mighty Contrivance is there preſerve theſe due Secretions from the Blood, n which Life ſo much depends,) by frequent ttritions, and Communications of the Fluids in eir Paſſage through the Heart, the Lungs, nd the whole Syſtem of the Muſcles? What leanders and Contortions of Veſſels, in the Or-ns of Separation? And, What a Concourſe of laſtick Bodies from the Air, to ſupply the prings, and continual Motions of ſome Parts, t only in Sleep, and Reſt; but in long violent xerciſes of the Muſcles? Whoſe Force drive e Fluids round in a wonderful rapid Circu-tion through the minuteſt Tubes, aſſiſted by e conſtant Pabulum of the Atmoſphere, and eir own Elaſtick Fibres, which impreſs that elocity on the Fluids.

Now I have mention'd ſome Uſes of the Air, carrying on ſeveral Functions in animal Bo-ies; I may add the Share it hath in all the Digeſtions of the ſolid and fluid Parts. For hen this Syſtem of Air comes, by Divine Per-ittance, to be corrupted with poyſonous, acri-onious Steams, either from the Earth, from Merchandiſe, or infected Bodies, What Havock s made in all the Operations of living Crea-ures? The Parts gangrene, and mortify under Carbuncles, and other Tokens: Indeed, the whole Animal Oeconomy is ruin'd; of ſuch Im-portance is the Air to all the Parts of it. Thus my learned Friend.

CHAP.

CHAP. VI.

Of the Placing the Parts of Man's Body.

IN this Chapter, I propoſe to conſider the Lodgment of the curious Parts of Man's Body, which is no leſs admirable than the Parts themſelves, all ſet in the moſt convenient Places of the Body, to miniſter to their own ſeveral Uſes and Purpoſes, and aſſiſt, and mutually to help one another. Where could thoſe faithful Watchmen the Eye, the Ear, the Tongue, be ſo commodiouſly placed, as in the upper Part of the Building? Where could we, throughout the Body, find ſo proper a Part to lodge four of the Five Senſes, as in the Head (*a*), near the Brain (*b*), the Common Senſory, a Place well guarded, and of little other Uſe than to be a Seat to thoſe Senſes? And, How could we lodge the fifth Senſe, that of *Touching* otherwiſe (*c*), than to diſperſe it to all Parts of the Body? Where could

(*a*) *Senſus, interpretes ac nuncii rerum, in capite, tanquam in arce, mirificè ad uſus neceſſarios & facti, & collocati ſunt. Nam oculi tanquam ſpeculatores, altiſſimum locum obtinent; ex quo plurima conſpicientes, fungantur ſuo munere. Et aures cum ſonum recipere debeant, quæ naturâ in ſublime fertur; rectè in illis corporum partibus collocatæ ſunt.* Cicer. de Nat. Deor. l. 2. c. 56. ubi plura de cæteris Senſibus.

(*b*) *Galen* well obſerves, That the Nerves miniſtring to Motion, are hard and firm, to be leſs ſubject to Injury; but thoſe miniſtring to Senſe, are ſoft and tender; and that for this Reaſon it is, that four of the Five Senſes are lodged ſo near the Brain, *viz.* partly to partake of the Brain's Softneſs and Tenderneſs, and partly for the Sake of the ſtrong Guard of the Skull. *Vid. Gal. de Uſ. Part. l.* 8. *c.* 5, 6.

(*c*) See *Book* IV. *Chap.* 6. *Note* (*c*). (*d*) *Quam*

ould we plant the Hand (*d*), but juſt where it is, be ready at every Turn, on all Occaſions of Help and Defence, of Motion, Action, and every f its uſeful Services? Where could we ſet the egs and Feet, but where they are, to bear up, and andſomely to carry about the Body? Where could e lodge the Heart, to labour about the Whole laſs of Blood, but in, or near the Centre of the ody (*e*)? Where could we find Room for that oble Engine to play freely in? Where could we well guard it againſt external Harms, as it is in at very Place in which it is lodg'd and ſecur'd? Where could we more commodiouſly place, than the Thorax and Belly, the uſeful *Viſcera* of oſe Parts, ſo as not to ſwag, and jog, and over- the Body, and yet to miniſter ſo harmoniouſly, they do, to all the ſeveral Uſes of Concoction, anguification, the Separation of various Ferments om the Blood, for the great Uſes of Nature, and make Diſcharges of what is uſeleſs, or would burdenſome or pernicious to the Body (*f*)? ow could we plant the curious and great Variety f Bones, and of Muſcles, of all Sorts and Sizes, eceſſary, as I have ſaid, to the Support, and every otion of the Body? Where could we lodge all e Arteries and Veins, to convey Nouriſhment; and

(*d*) *Quàm verò aptas, quamque multarum artium miniſtras Manus atura homini dedit?* The Particulars of which, enumerated y him, ſee in *Cic. ubi ſupra, c.* 60.

(*e*) See *Book* VI. *Chap.* 5.

(*f*) *Ut in ædificiis Architecti avertunt ab oculis & naribus domino- um ea, quæ profluentia neceſſariò tetri eſſent aliquid habitura; ſic na- ura res ſimiles (ſcil. excrementa) procul admandavit à ſenſibus.* Cicer. e Nat. Deor. l. 2. c. 56.

and the Nerves, Senſation throughout the Body? Where, I ſay, could we lodge all theſe Implements of the Body, to perform their ſeveral Offices? How could we ſecure and guard them ſo well, as in the very Places, and in the ſelf ſame Manner in which they are already plac'd in the Body? And laſtly, to name no more, What Covering, what Fence could we find out for the whole Body, better than that of Nature's own providing, the Skin (*g*)? How could we ſhape it to, or brace it about every Part better, either for Convenience or Ornament? What better Texture could we give it, which although leſs obdurate and firm, than that of ſome other Animals; yet is ſo much the more ſenſible of every touch, and more compliant with every Motion? And being eaſily defenſible by the Power of Man's Reaſon and Art, is therefore much the propereſt Tegument for a Reaſonable Creature.

(*g*) Compare here *Galen*'s Obſervations *de Uſ. Part. l.* 11. *c.* 15. Alſo *l.* 2. *c.* 6. See alſo *Cowper Anat.* where in *Tab.* 4. are very elegant Cuts of the Skin in divers Parts of the Body, drawn from microſcopical Views; as alſo of the *papillæ Pyramidales*, the *ſudoriferous Glands* and Veſſels, the *Hairs*, &c.

CHAP. VII.

Of the Proviſion in Man's Body againſt Evils.

HAving taken a tranſient View of the Structure and Lodgment of the Parts of Human Bodies, let us next conſider the admirable Proviſion that is made throughout Man's Body, to ſtave off Evils and

nd to diſcharge (*a*) them when befallen. For the revention of Evils, we may take the Inſtances al-eady given, of the Situation of thoſe faithful Sen-incls, the Eye, the Ear, and Tongue, in the ſupe-iour Part of the Body, the better to deſcry Dan-ers at a Diſtance, and to call out preſently for elp. And how well ſituated is the Hand to be a ire and ready Guard to the Body, as well as the ithful Performer of moſt of its Services? The rain, the Nerves, the Arteries, the Heart (*b*), the ungs; and in a Word, all the principal Parts, ow well are they barricaded, either with ſtrong ones, or deep Lodgments in the Fleſh, or ſome ch the wiſeſt and fitteſt Method, moſt agreeable to e Office and Action of the Part? Beſides which, r greater Precaution, and a farther Security, what incomparable Proviſion hath the Infinite Contri-er of Man's Body made for the Loſs of, or any De-ct in, ſome of the Parts we can leaſt ſpare, by oubling them? By giving us two Eyes, two Ears, wo Hands, two Kidneys, two Lobes of the Lungs, Pairs

(*a*) One of Nature's moſt conſtant Methods here, is by the *lands*, and the *Secretions* made by them; the Particulars of hich being too long for theſe Notes, I ſhall refer to the odern Anatomiſts, who have written on theſe Subjects; and deed, who are the only Men that have done it tolerably: articularly, our learned Doctors *Cockburn*, *Keil*, *Morland*, and hers at Home and Abroad: An Abridgment of whoſe Opi-ons and Obſervations, for the Reader's Eaſe, may be met ith in Dr. *Harris*'s *Lex. Tech. Vol.* 2. under the Words *Glands*, d *Animal Secretion*.

(*b*) In Man, and moſt other Animals, the Heart hath the uard of Bones; but in the *Lamprey*, which hath no Bones, o not ſo much as a Back-bone,) *the Heart is very ſtrangely ſecured, d lies immur'd, or capſulated in a Cartilage, or griſly Subſtance, which cludes the Heart, and its Auricle, as the Skull——doth the Brain in o-r Animals.* Power's Microſ. Obſ. 22.

Pairs of the Nerves, and many Ramifications of the Arteries and Veins in the fleshy Parts, that there may not be a Defect of Nourishment of the Parts, in Cases of Amputation, or Wounds, or Ruptures of any of the Vessels.

And as Man's Body is admirably contriv'd, and made to prevent Evils; so no less Art and Caution hath been used to get rid of them, when they do happen. When by any Misfortune, Wounds or Hurts do befal; or, when by our own wicked Fooleries and Vices, we pull down Diseases and Mischiefs upon our selves, what Emunctories (*c*), what admirable Passages (*d*), are dispers'd throughout the Body; what incomparable Methods doth Na-

(*c*) *Here* [from the Pustules he observ'd in Monomotapa,] *were Grounds to admire the Contrivance of our Blood, which on some Occasions, so soon as any Thing destructive to the Constitution of it, comes into it, immediately by an inteſtine Commotion, endeavoureth to thrust it forth, and is not only freed from the new Guest; but sometimes what likewise may have lain lurking therein——for a great while. And from hence it comes to pass, That most Part of Medicines, when duly administred, are not only sent out of the Body themselves; but likewise great Quantities of morbifick Matter: As in Salivation*, &c. Dr. *Sloane*'s Voy. to *Jamaica*, p. 25.

(*d*) *Valsalva* discover'd some Passages into the Region of the *Ear-drum*, of mighty Use, (among others,) to make Discharges of Bruises, Impostbumes, or any prulent, or morbifick Matter from the Brain, and Parts of the Head. Of which he gives two Examples: One, a Person, who from a Blow on his Head, had dismal Pains therein, grew Speechless, and lay under an absolute Suppression and Decay of his Strength; but found certain Relief, whenever he had a Flux of Blood, or purulent Matter out of his Ear; which after his Death *Valsalva* discover'd, was through those Passages.

The other was an *Apoplectical Case*, wherein he found a large Quantity of extravasated Blood, making Way from the Ventricles of the Brain, through those same Passages. *Valsal. de Aure hum. c.* 2. *sect.* 14. and *c.* 5. *sect.* 8.

(*e*) *Hip-*

Nature take (*e*); what vigorous Efforts is ſhe enabled to make, to diſcharge the peccant Humours, to

(*e*) *Hippocrates Lib. de Alimentis*, takes Notice of the Sagacity of Nature, in finding out Methods and Paſſages for the diſcharging Things offenſive to the Body, of which the late learned and ingenious Biſhop of *Clogher*, in *Ireland*, (*Boyle*,) gave this remarkable Inſtance, to my very curious and ingenious Neighbour and Friend, *D'Acre Barret*, Eſq; *viz.* That in the Plague Year, a Gentleman at the Univerſity, had a large Plague Sore gathered under his Arm, which, when they expected it would have broken, diſcharged it ſelf by a more than ordinary large and fœtid Stool; the Sore having no other Vent for it, and immediately becoming ſound and well thereon.

Like to which, is the Story of *Joſ. Lazonius*, of a Soldier of thirty-five Years of Age, who had a Swelling in his Right Hip, accompany'd with great Pain, &c. By the Uſe of emollient Medicines, having ripened the Sore, the Surgeon intended the next Day to have opened it; but about Midnight, the Patient having great Provocations to Stool, disburthen'd himſelf three Times; immediately upon which, both the Tumour and Pain ceaſed, and thereby diſappointed the Surgeon's Intentions. *Ephem. Germ. Anno* 1690. *Obſ.* 49. More ſuch Inſtances we find of Mr. *Tonges*, in *Philoſoph. Tranſ.* No. 323. But indeed there are ſo many Examples of this Nature in our *Philoſoph. Tranſ.* in the *Ephem. German*, *Tho. Bartholine*, *Rhodius*, *Sennertus*, *Hildanus*, &c. that it would be Endleſs to recount them. Some have ſwallow'd Knives, Bodkins, Needles and Pins, Bullets, Pebbles, and twenty other ſuch Things as could not find a Paſſage the ordinary Way, but have met with an *Exit* through the Bladder, or ſome other Way of Nature's own providing. But paſſing over many Particulars, I ſhall only give one Inſtance more, becauſe it may be a good Caution to ſome Perſons, that theſe Papers may probably fall into the Hands of; and that is, the Danger of ſwallowing *Plumb-ſtones*, *Prune-ſtones*, &c. Sir *Francis Butler*'s Lady had many *Prune-ſtones* that made Way through an Abſceſs near her Navel. *Philoſoph. Tranſ.* No. 265, where are other ſuch like Examples. More alſo may be found in No. 282, 304, &c. And at this Day, a young Man, living not far off me, labours under very troubleſome and dangerous Symptoms, from the Stones of *Sloes* and *Bullace*, which he ſwallow'd eight or ten Years ago.

to correct the morbifick Matter; and in a Word, to ſet all Things right again? But here we had beſt take the Advice of a learned Phyſician in the Caſe: "The Body, (ſaith he,) is ſo contrived, as to be "well enough ſecured againſt the Mutations in the "Air, and the leſſer Errors we daily run upon; "did we not in the Exceſſes of Eating, Drinking, "Thinking, Loving, Hating, or ſome other Folly, "let in the Enemy, or lay violent Hands upon our "ſelves. Nor is the Body fitted only to prevent; "but alſo to cure, or mitigate Diſeaſes, when by "theſe Follies brought upon us. In moſt Wounds, "if kept clean, and from the Air, ——the Fleſh "will glew together, with its own native Balm. "Broken Bones are cemented with the *Callus*, "which themſelves help to make". And ſo he goes on with ample Inſtances in this Matter, too many to be here ſpecify'd (*f*). Among which he inſtanceth in the Diſtempers of our Bodies, ſhewing, That even many of them are highly ſerviceable to the Diſcharge of malignant Humours, and preventing greater Evils.

And no leſs Kind than Admirable is this Contrivance of Man's Body, that even its Diſtempers ſhould many Times be its Cure (*g*); that when the Enemy

(*f*) Grew's *Coſm. l. Sect.* 28, 29.

(*g*) *Nor are Diſeaſes themſelves uſeleſs: For the Blood in a Fever, if well-govern'd, like Wine upon the Fret, diſchargeth it ſelf of all heterogeneous Mixtures; and Nature, the Diſeaſe, and Remedies, clean all the Rooms of the Houſe; whereby that which threatens Death, tends, in Concluſion, to the prolonging of Life.* Grew, ubi ſupr. ſect. 52.

And as Diſeaſes miniſter ſometimes to Health; ſo to other good Uſes in the Body, ſuch as quickning the Senſes: Of which take theſe Inſtances relating to the Hearing and Sight.

A very

Enemy lies lurking within to deſtroy us, there ſhould be ſuch a Reluctancy, and all Nature excited with its utmoſt Vigour to expel him thence. To which Purpoſe, even Pain it ſelf is of great and excellent Uſe, not only in giving us Notice of the Preſence of the Enemy, but by exciting us to uſe our utmoſt Diligence and Skill to root out ſo troubleſome and deſtructive a Companion.

A very ingenious Phyſician falling into an odd Kind of Fever, had his Senſe of Hearing thereby made ſo very nice and tender, that he very plainly heard ſoft Whiſpers, that were made at a conſiderable Diſtance off, and which were not in the leaſt perceiv'd by the By-ſtanders, nor would have been by him before his Sickneſs.

A Gentleman of eminent Parts and Note, during a Diſtemper he had in his Eyes, had his Organs of Sight brought to be ſo tender, that both his Friends, and himſelf have aſſur'd me, That when he wak'd in the Night, he could for a while plainly ſee and diſtinguiſh Colours, as well as other Objects, diſcernable by the Eye, as was more than once try'd. Boyl. deter. nat. of Effluv. ch. 4.

Daniel Fraſer——*continu'd Deaf and Dumb from his Birth, till the 17th Year of his Age——After his Recovery from a Fever, he perceiv'd a Motion in his Brain, which was very uneaſy to him; and afterwards he began to hear, and in Proceſs of Time, to underſtand Speech,* &c. Vid. Philoſ. Tranſ. No. 312.

CHAP. VIII.

Of the Conſent between the Parts of Man's Body.

IT is an admirable Proviſion the merciful Creator hath made for the Good of Man's Body, by the Conſent and Harmony between the Parts thereof: Of which let us take St. *Paul*'s Deſcription, in 1 *Cor.* xii. 8. *But now hath God ſet the Members, every one of them in the Body, as it hath pleaſed him.* And ver. 21. *The Eye cannot*

ſay unto the Hand, I have no need of thee: Nor again, the Head to the Feet, I have no need of you. But ſuch is the Conſent of all the Parts, or as the Apoſtle wordeth it, *God hath ſo tempered the Body together, that the Members ſhould have the ſame Care one for another*, ver. 25. So that *whether one Member ſuffer, all the Members ſuffer with it; or one Member be honoured* (or affected with any good,) *all the Members rejoyce* [and ſympathize] *with it*, ver. 26.

This mutual Accord, Conſent and Sympathy of the Members, there is no Reaſon to doubt (*a*), is made by the Commerce of the Nerves (*b*), and their artificial Poſitions, and curious Ramifications throughout the whole Body, which is admirable and incomparable, and might deſerve a Place in this Survey, as greatly, and manifeſtly ſetting forth the Wiſdom and Benignity of the Great Creator; but that to give a Deſcription thereof from the Origin of the Nerves, in the *Brain*, the *Cerebellum* and *Spine*, and ſo through every Part of the Body, would be tedious, and intrench too much upon the Anatomiſt's Province: And therefore one Inſtance ſhall ſuffice for a Sample of the Whole; and that ſhall be, (what was promis'd before

(*a*) See *Book* 4. *Chap.* 8.

(*b*) *Tria propoſita ipſi Naturæ in Nervorum diſtributione fuerunt.* 1. *Ut ſenſoriis inſtrumentis Senſum impertiret.* 2. *Ut motoriis Motum.* 3. *Ut omnibus aliis* [*partibus*] *daret ut quæ ſi dolorem adferrent, dignoſcerent.* And afterwards, *Si quis in diſſectionibus ſpectavit, conſideravitque juſtène, an ſecus Natura Nervos non eâdem menſurâ omnibus partibus diſtribuerit, ſed aliis quidem liberaliùs, aliis verò parciùs, eadem cum Hippocrate, velit nolit, de Naturâ omnino pronunciabit, quòd ea ſcilicet ſagax, juſta, artificioſa, animalium que provida eſt.* Galen. de Uſ. Part. l. 5. c. 9.

(*f*) Be-

bre (*c*), the great Sympathy occaſion'd by the *Fifth Pair* of Nerves; which I chuſe to inſtance n, rather than the *Par vagum*, or any other of the Nerves, becauſe although we may have leſs Varie- of noble Contrivance and Art, than in that air; yet we ſhall find enough for our Purpoſe, nd which may be diſpatch'd in fewer Words. Now this *Fifth Conjugation* of *Nerves*, is branch- d to the Ball, the Muſcles, and Glands of the Eye; the Ear; to the Jaws, the Gums, and Teeth; the Muſcles of the Lips (*d*); to the Tonſils, e Palate, the Tongue, and the Parts of the outh; to the *Præcordia* alſo, in ſome Meaſure, inoſculating with one of its Nerves; and laſtly, the Muſcles of the Face, particularly the Cheeks, hoſe ſanguiferous Veſſels it twiſts about.

From hence it comes to paſs, that there is a reat Conſent and Sympathy (*e*) between theſe arts; ſo that a guſtable Thing ſeen or ſmelt, ex- ites the Appetite, and affects the Glands and arts of the Mouth; that a Thing ſeen or heard, hat is ſhameful, affects the Cheeks with modeſt luſhes; but on the contrary, if it pleaſes and ickles the Fancy, that it affects the *Præcordia*, and

(*c*) *Book* 4. *Chap.* 5.

(*d*) Dr. *Willis* gives the Reaſon, *cur mutua Amaſiorum oſculæ biis impreſſa, tum præcordia, tam genitalia afficiendo, amorem ac bidinem tam facilè irritant*, to be from the Conſent of thoſe arts, by the Branches of this Fifth Pair. *Nerv. Deſcr. c.* 22.

And Dr. *Sachs* judges it to be from the Conſent of the *La- a Oris cum Labiis Uteri*, that in *April* 1669, a certain breed- ng Lady, being affrighted with ſeeing one that had ſcabby Lips, which they told her were occaſion'd by a peſtilential Fever, had ſuch like Puſtules brake out in the *Labia Uteri*. Ephem. Germ. T. 1. Obſ. 20.

(*e*) Con-

and Muſcles of the Mouth and Face with Laughter; but a Thing cauſing Sadneſs and Melancholy, doth accordingly exert it ſelf upon the *Præcordia*, and demonſtrate it ſelf by cauſing the Glands of the Eyes to emit Tears (*f*), and the Muſcles of the Face to put on the ſorrowful Aſpect of Crying. Hence alſo that torvous ſour Look produc'd by Anger and Hatred: And that gay and pleaſing Countenance accompanying Love and Hope. And in ſhort, it is by Means of this Communication of the Nerves, that whatever affects the Soul, is demonſtrated, (whether we will or no,) by a conſentaneous Diſpoſition of the *Præcordia* within, and a ſuitable Configuration of the Muſcles and Parts of the Face without. And an admirable Contrivance of the Great GOD of *Nature* this is; That as a Face is given to Man, and as *Pliny* ſaith (*g*), to Man alone of all Creatures; ſo it ſhould be, (as he obſerves,) *the Index of Sorrow and Chearfulneſs, of Compaſſion and Severity. In its aſcending Part is the Brow, and therein a Part of the Mind too. Therewith we deny, therewith we conſent. With this it is we ſhew our Pride, which hath its Source in another Place; but here its Seat: In the Heart it hath its Birth; but here it abides and dwells; and that becauſe it*

(*e*) Conſult *Willis ubi ſuprà*.

(*f*) Tears ſerve not only to moiſten the Eye, to clean and brighten the *Cornea*, and to expreſs our Grief; but alſo to alleviate it, according to that of *Ulyſſes* to *Andromache*, in *Seneca's Troas*, ver. 762.

Tempus moramque dabimus, arbitrio tuo
Implere lacrymis: Fletus ærumnas levat.

(*g*) *Plin.* Nat. Hiſt. l. 11. c. 37.

(*b*) Nihil

could find no other Part throughout the Body higher, or more craggy (*b*), *where it might reſide alone.*

Thus I have diſpatch'd what I ſhall remark concerning the Soul and Body of Man. There are divers other Things, which well deſerve a Place in this Survey; and theſe that I have taken Notice of, deſerv'd to have been enlarg'd upon: But what hath been ſaid, may ſuffice for a Taſte and Sample of this admirable Piece of God's Handy-work; at leaſt ſerve as a Supplement to what others have ſaid before me. For which Reaſon I have endeavour'd to ſay as little wittingly as I could, of what they have taken Notice of, except where the Thread of my Diſcourſe laid a Neceſſity upon me.

(*b*) *Nihil altius ſimul abruptiuſque invenit.*

CHAP. IX.

Of the Variety of Mens Faces, Voices, and Hand-Writing.

HERE I would have put an End to my Obſervations relating to Man; but that there are three Things ſo expreſly declaring the Divine Management and Concurrence, that I ſhall juſt mention them, although taken Notice of more amply by others; and that is, The great Variety throughout the World of Mens Faces (*a*), Voices (*b*), and

(*a*) If the Reader hath a Mind to ſee Examples of Men's Likeneſs, he may conſult *Valer. Maximus*, *l.* 9. *c.* 14. concerning the Likeneſs of *Pompey* the Great, and *Vibius*, and *Publicius*

(*b*), and Hand-writing. Had Man's Body been made according to any of the Atheiſtical Schemes, or any other Method than that of the Infinite Lord of the World, this Wiſe Variety would never have been: But Mens Faces would have been cast in the ſame, or not a very different Mould; their Organs of Speech would have ſounded the ſame, or not ſo great a Variety of Notes; and the ſame Structure of Muſcles and Nerves, would have given the Hand the ſame Direction in Writing. And in this Caſe, what Confuſion, what Diſturbance, what Miſchiefs would the World eternally have lain under? No Security could have been to our Perſons; no Certainty, no Enjoyment of our Poſſeſſions (*c*); no Juſtice between Man and Man, no

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Publicius Libertinus; as alſo of *Pompey* the Father, who got the Name of *Coquus*, he being like *Menogenes* the Cook; with divers others.

(*b*) As the Difference of Tone makes a Difference between every Man's Voice, of the ſame Country, yea, Family; ſo a different Dialect and Pronunciation, differs Perſons of divers Countries; yea, Perſons of one and the ſame Country, ſpeaking the ſame Language: Thus in *Greece*, there were the *Ionick*, *Dorick*, *Attick*, and *Æolick* Dialects. So in *Great-Britain*, beſides the grand Diverſity of *Engliſh* and *Scotch*, the different Counties vary very much in their Pronunciation, Accent and Tone, although all one and the ſame Language. And the Way of the *Gileadites* proving the *Ephraimites*, *Judg.* xii. 6. by the Pronunciation of *Shibboleth*, with a *Schin*, or *Sibboleth* with a *Samech*, is well known. So *à Lapide* ſaith, the *Flemings* prove whether a Man be a *Frenchman* or not, by bidding him pronounce *Acht en tachtenticht*; which they pronounce, *Act en tactentic*, by Reaſon they can't pronounce the Aſpirate *h*.

(*c*) *Regi Antiocho unus ex æqualibus——nomine Artemon, per quam ſimilis fuiſſe traditur. Quem Laodice, uxor Antiochi, interfecto vivo, diſſimulandi ſceleris gratiâ, in lectulo perinde quaſi Regem ægrum collocavit. Admiſſumque univerſum populum, & ſermone ejus*

o Diſtinction between Good and Bad, between riends and Foes, between Father and Child, lusband and Wife, Male or Female; but all would ave been turn'd topſey-turvey, by being expos'd o the Malice of the Envious and Ill-natur'd, to he Fraud and Violence of Knaves and Robbers, o the Forgeries of the crafty Cheat, to the Luſts f the Effeminate and Debauch'd, and what not! ur Courts of Juſtice (*d*), can abundantly teſtify he dire Effects of miſtaking Men's Faces, of coun-rfeiting their Hands, and forging Writings. But ow, as the Infinitely Wiſe Creator and Ruler ath order'd the Matter, every Man's Face can di-inguiſh him in the Light, and his Voice in the ark; his Hand-writing can ſpeak for him though bſent, and be his Witneſs, and ſecure his Contracts n future Generations. A manifeſt, as well as ad-nirable Indication of the Divine Superintendence nd Management (*e*).

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vultu conſimili fefellit: crediderunt que homines ab Antiocho moriente Laodicen & natos ejus ſibi commendari. Valer. Max. ib.

(*d*) *Quid Trebellius Calca! quàm aſſeveranter ſeſe Clodium tulit! & quidem dum de bonis ejus contendit, in centumvirale judicium adeò favorabilis deſcendit, ut vix juſtis & æquis ſententiis conſternatio populi illum relinqueret locum. In illâ tamen quæſtione neque calumniæ petitoris, neque violentiæ plebis judicantium religio ceſſit.* Val. Max. b. c. 15.

(*e*) To the foregoing Inſtances of Divine Management, with relation to the political State of Man, I ſhall add another Thing, that I confeſs hath always ſeem'd to me ſomewhat odd, but very providential; and that is, the Value that Mankind, at leaſt the civiliz'd Part of them, have in all Ages put upon Gems, and the purer finer Metals, Gold and Silver; ſo as to think them equivalent unto, and exchange them for Things of the greateſt Uſe for Food, Cloathing, and all other Neceſſaries and Conveniences of Life. Whereas thoſe Things themſelves are of very little, if any Uſe in Phyſick, Food, Building or Cloathing, otherwiſe than for Ornament, or to miniſter to Luxury; as *Suetonius* tells us of

of *Nero*, who fiſh'd with a Net gilt with Gold, and ſhod his Mules with Silver; but his Wife *Poppæa*, ſhod her Horſes with Gold. *Vit. Ner. c.* 30. *Plin. N. H. L.* 33. *c.* 11. So the ſame *Suetonius* tells us, *Jul. Cæſar* lay in a Bed of Gold, and rode in a Silver Chariot. But *Heliogabilus* rode in one of Gold, and had his Cloſe-ſtool Pans of the ſame Metal. And *Pliny* ſaith, *Vaſa Coquinaria ex argento Calvus Orator fieri queritur. Ibid.* Neither are thoſe precious Things of greater Uſe to the making of Veſſels, and Utenſils, (unleſs ſome little Niceties and Curioſities,) by Means of their Beauty, Imperdibility, and Ductility. Of which laſt, the great Mr. *Boyle* hath among others, theſe two Inſtances, in his *Eſſay about the Subtility of Effluviums*, Chap. 2. *Silver, whoſe Ductility, and Tractility, are very much inferiour to thoſe of Gold, was, by my procuring, drawn out to ſo ſlender a Wire, that——a ſingle Grain of it amounted to twenty ſeven Feet.* As to Gold, he demonſtrates it poſſible to extend an Ounce thereof, to reach to 777600 Feet, or 155 Miles and an half, yea, to an incredibly greater Length.

And as to Gems, the very Stories that are told of their prodigious Virtues, are an Argument, that they have very little, or none more than other hard Stones. That a *Diamond* ſhould diſcover whether a Woman be true or falſe to her Husband's Bed; cauſe Love between Man and Wife; ſecure againſt Witchcraft, Plague and Poiſons; that the *Ruby* ſhould diſpoſe to Cheerfulneſs, cauſe pleaſant Dreams, change its Colour againſt a Misfortune befalling, *&c.* that the *Sapphire* ſhould grow foul, and loſe its Beauty, when worn by one that is Leacherous; that the *Emerald* ſhould fly to pieces, if it touch the Skin of any unchaſte Perſon in the Act of Uncleanneſs: That the *Chryſolite* ſhould loſe its Colour, if Poyſon be on the Table, and recover it again when the Poyſon is off: And, to name no more, that the *Turcoiſe*, (and the ſame is ſaid of a Gold Ring,) ſhould ſtrike the Hour when hung over a drinking Glaſs, and much more to the ſame Purpoſe: All theſe, and many other ſuch fabulous Stories, I ſay, of Gems, are no great Arguments, that their Virtue is equivalent to their Value. Of theſe, and other Virtues, conſult *Worm* in his *Muſeum*, *l.* 1. *ſect.* 2. *c.* 17, *&c.*

But as to *Gems* changing their Colour, there may be ſomewhat of Truth in that, particularly in the *Turcoiſe* laſt mention'd. Mr. *Boyle* obſerv'd the Spots in a *Turcoiſe*, to ſhift their Place from one Part to another, by gentle Degrees. So did the Cloud in an *Agate*-handle of a Knife. A *Diamond* he wore on his Finger, he obſerv'd to be more illuſtrious at ſome Times than others: Which a curious Lady told him ſhe had alſo obſerv'd in hers. So likewiſe a rich *Ruby* did the ſame. *Boyle* of *Abſol. Reſt in Bodies.*

CHAP.

CHAP. X.

The Concluſion of the Survey of MAN.

AND now having taken a View of *Man*, and finding every Part of him, every Thing relating to him contriv'd, and made in the very beſt manner; his Body fitted up with the utmoſt Foreſight, Art and Care; and this Body, (to the great honour, Privilege, and Benefit of Man,) poſſeſs'd by a Divine Part, the *Soul*, a Subſtance made as it were on Purpoſe to contemplate the Works of God, and glorify the Great Creator; and ſince this Soul can diſcern, think, reaſon, and ſpeak; What can we conclude upon the whole Matter, but that we lie under all the Obligations of Duty and Gratitude, to be thankful and obedient to, and to ſet forth the Glories of our Great Creator, and Noble Benefactor? And what ungrateful Wretches are we, how much worſe than the poor Irrationals, if we do not employ the utmoſt Power of our Tongue, and all our Members, and all the Faculties of our Souls in the Praiſes of God! But above all, ſhould we, who have the Benefit of thoſe Glorious Acts and Contrivances of the Creator, be ſuch wicked, ſuch baſe, ſuch worſe than brutal Fools, to deny the Creator (*a*), in ſome of his nobleſt Works? Should

(*a*) It was a pious, as well as juſt Concluſion, the ingenious *Laurence Bellini* makes of his *Opuſculum de Motu Cordis*, in theſe Words: *De Motu Cordis iſthæc. Quæ equidem omnia, ſi à rudi intelligentiâ Hominis tantum conſilii, tantum ratiocinii, tantum peritiæ mikè rerum, tantum ſcientiarum exigunt, ad hoc, ut inveniantur, ſeu*

ad

Should we ſo abuſe our Reaſon, yea, our very Senſes; ſhould we be ſo beſotted by the Devil, and blinded by our Luſts, as to attribute one of the beſt contriv'd Pieces of Workmanſhip to blind Chance, or unguided Matter and Motion, or any other ſuch ſottiſh, wretched, atheiſtical Stuff, which we never ſaw, nor ever heard made any one Being (*b*) in any Age ſince the Creation? No, No! But like wiſe and unprejudic'd Men, let us with *David* ſay, *Pſalm* cxxxix. 14. (with which I conclude,) *I will praiſe thee, for I am*

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ad hoc, ut percipiantur poſtquam facta ſunt; illum, cujus operâ, ſalm. facta ſunt hæc ſingula, tam vani erimus atque inanes, ut exiſtimemus eſſe conſilii impotem, rationis expertem, imperitum, aut ignarum omnium rerum? Quantum ad me attinet, nolim eſſe Rationis compos, ſi tantum inſudandum mihi eſſet ad conſequendam intelligentiam earum rerum, quas fabrefaceret neſcio quæ Vis, quæ nihil intelligeret eorum quæ fabrefaceret; mihi etenim viderer eſſe vile quiddam, atque ridiculum, qui vellem totam ætatem meam, ſanitatem, & quicquid humanum eſt deterere, nihil curare quicquid eſt jucunditatum, quicquid lætitiarum, quicquid commodorum; non divitias, non dignitates: non pœnas etiam, & vitam ipſam, ut gloriari poſſem poſtremò inveniſſe unum, aut alterum, & fortaſſe me inveniſſe quidem ex iis innumeris, quæ produxiſſe, neſcio quis ille, qui ſine labore, ſine curâ, nihil cogitans, nihil cognoſcens, non unam aut alteram rem, neque dubiè, ſed certò produxiſſet innumeras innumerabilitates rerum in hoc tam immenſo ſpatio corporum, ex quibus totus Mundus compingitur. Ah Deum immortalem! Video præſens numen tuum in hiſce tam prodigioſis Generationis initiis, & in altiſſimâ eorum contemplatione defixus, neſcio quo œſtro admirationis conciter, & quaſi divine furens cohiberi me minimè poſſum quin exclamem.

Magnus Dominus! Magnus Fabricator Hominum Deus! Magnus atque Admirabilis! Conditor rerum Deus quàm Magnus es! Bellin. de Mot. Cord. fin.

(*b*) *Hoc* [*i. e.* mundum effici ornatiſſimum, & pulcherrimum eſt concurſione fortuitâ] *qui exiſtimat fieri potuiſſe, non intelligo cur non idem putet, ſi innumerabiles unius, & viginti formæ literarum, vel aureæ, vel qualeſlibet, aliquo conjiciantur, poſſe ex his in terram excuſſis annales Ennii ut deinceps legi poſſint, effici, &c.——Quæ ſi Mundum efficere poteſt concurſus Atomorum, cur porticum, cur templum, cur domum, cur urbem non poteſt? Quæ ſunt minus operoſa, & multò quidem faciliora.* Cic. de Nat. Deor. l. 2. c. 37.

fear-

fearfully and wonderfully made; marvellous are thy Works, and that my Soul knoweth right well.

Having thus made what (conſidering the Copiouſneſs and Excellence of the Subject,) may be called a very brief Survey of *Man*, and ſeen ſuch admirable Marks of the Divine Deſign and Art; let us next take a tranſient view of the other inferiour Creatures; and begin with Quadrupeds.

BOOK VI.

A SURVEY of QUADRUPEDS.

CHAP. I.

Of their Prone POSTURE.

IN taking a View of this Part of the Animal World, ſo far as the Structure of their Bodies is conformable to that of Man, I ſhall paſs them by, and only take Notice of ſome Peculiarities in them, which are plain Indications of Deſign, and the Divine Super-intendence and Management. And, 1. The moſt viſible apparent Variation is the *Prone Poſture of their Body*: Concerning which, I ſhall take Notice only of two Things, the Parts miniſtring thereto, and the Uſe and Benefit thereof.

I. As for the Parts, it is observable, That in all these Creatures, the *Legs* are made exactly conformable to this Posture, as those in Man are to his erect Posture: And what is farther observable also, is, That the Legs and Feet are always admirably suited to the Motion and Exercises of each Animal: In some they are made for Strength only, to support a vast, unwieldy Body (*a*); in others they are made for Agility and Swiftness (*b*), in some they are made for only Walking and Running, in others for that, and Swimming too (*c*); in others for Walking and Digging (*d*); and in others for Walk-

(*a*) The Elephant being a Creature of prodigious Weight, the largest of all Animals, *Pliny* saith, hath its Legs accordingly made of an immense Strength, like Pillars, rather than Legs.

(*b*) Deer, Hares, and other Creatures, remarkable for Swiftness, have their Legs accordingly slender, but withal strong, and every Way adapted to their Swiftness.

(*c*) Thus the Feet of the *Otter* are made, the Toes being all conjoined with Membranes, as the Feet of Geese and Ducks are. And in Swimming, it is observable, That when the Foot goes forward in the Water, the Toes are close; but when backward, they are spread out, whereby they more forcibly strike the Water, and drive themselves forward. The same may be observed also in Ducks and Geese, &c.

Of the *Castor* or *Beaver*, the *French* Academists say, *The Structure of the Feet was very extraordinary, and sufficiently demonstrated, that Nature hath designed this Animal to live in the Water, as well as upon Land. For although it had four Feet, like Terrestrial Animals, yet the hindmost seemed more proper to swim than walk with, the Five Toes of which they were compos'd, being joined together like those of a Goose by a Membrane, which serves this Animal to swim with. But the fore Ones were made otherwise; for there was no Membrane which held those Toes joined together: And this was requisite for the Conveniency of this Animal, which useth them as Hands, like a Squirrel, when he eats.* Memoirs for a Natural History of Animals, *pag.* 84.

(*d*) The *Mole*'s Feet are a remarkable Instance.

(*e*) The

Walking and Flying (*e*): In some they are made more laks and weak, for the plainer Lands; in others rigid, stiff, and less flexible (*f*), for traversing the Ice, and dangerous Precipices of the high Mountains (*g*); in some they are shod with tough and hard Hoofs, some whole, some cleft; in others with only a callous Skin. In which latter, it is observable that the Feet are composed of Toes, some short for bare-going; some long to supply the Place of a Hand (*h*); some armed with long and strong Talons to catch, hold, and tear the Prey; some fenced only with short Nails, to confirm the Steps in Running and Walking.

II. As the Posture of Man's Body is the fittest for a Rational Animal, so is the Prone Posture of *Quadrupeds* the most useful and beneficial to themselves

(*e*) The Wings of the *Bat* are a prodigious Deviation from Nature's ordinary Way. So it is in the *Virginian Squirrel*, whose Skin is extended between the Fore-legs and its Body.

(*f*) Of the Legs of the *Elk*, the *French* Academists say, *Although some Authors report, That there are* Elks *in* Muscovia, *whose Legs are jointless; there is great Probability, that this Opinion is founded on what is reported of those* Elks *of* Muscovia, *as well as of* Cæsar's Alce, *and* Pliny's Machlis, *that they have Legs so stiff and inflexible, that they do run on Ice without slipping; which is a Way that is reported that they have to save themselves from the Wolves, &c.* Ibid. p. 108.

(*g*) The common tame *Goat*, (whose Habitation is generally on Mountains and Rocks, and who delighteth to walk on the Tops of Pales, Houses, &c. and to take great and seemingly dangerous Leaps) I have observ'd, hath the Joints of the Legs very stiff and strong, the Hoof hollow underneath, and its Edges sharp. The like, I doubt not, is to be found in the *Wild Goat*, considering what Dr. *Scheuchzer* hath said of its climbing the most dangerous Craggs of the *Alps*, and the Manner of their hunting it. *Vid. Iter. Alpin.* 3. *p.* 9.

(*h*) Thus in *Apes* and *Monkeys*, in the *Beaver* before, and divers others.

ſelves, as alſo moſt ſerviceable to Man. For they are hereby better made for their gathering their Food, to purſue their Prey, to leap, to climb, to ſwim, to guard themſelves againſt their Enemies; and in a Word, to do whatever may be of principal Uſe to themſelves; as alſo, they are hereby rendered more uſeful and ſerviceable to Man, for carrying his Burdens, for Tilling his Ground; yea, even for his Sports and Diverſions.

And now I might here add a Survey of the excellent Contrivances of the Parts miniſtring to this Poſture of the four-footed Animals, the admirable Structure of the Bones (*i*), the Joints and Muſcles, their various Sizes and Strength; their commodious Lodgment and Situation, the nice Æquipoiſe of the Body, with a great deal more to the ſame Purpoſe. But I ſhould be tedious to inſiſt minutely upon ſuch Particulars; and beſides, I have given a Touch upon theſe Kinds of Things, when I ſpake of Man.

Paſſing by therefore many Things of this Kind, that might deſerve Remark, I ſhall only conſider ſome of the Parts of the *Quadrupeds*, differing from what is found in Man (*k*), and which are manifeſt Works of Deſign.

(*i*) It is a ſingular Proviſion Nature hath made for the Strength of the *Lion*, if that be true, which *Galen* ſaith is reported of its Bones being not hollow (as in other Animals) but ſolid: Which Report he thus far confirms, that moſt of the Bones are ſo; and that thoſe in the Legs, and ſome other Parts, have only a ſmall and obſcure Cavity in them. *Vid. Galen. de Uſ. Part. l.* 11. *c.* 18.

(*k*) *Theſe Sorts of Differences in the Mechaniſm of Animals, upon the Score of the Poſition of their Bodies, occur ſo often, that it would be no mean Service to Anatomy——if any one would give us a Hiſtory of theſe Variations of the Parts of Animals, which ſpring from the different Poſtures of their Bodies.* Drake Anat. V. 1. B. 1. c. 17.

CHAP.

CHAP. II.

Of the Heads of Quadrupeds.

IT is remarkable, that in Man, the Head is of one ſingular Form; in the four-footed Race, as various as their Species. In ſome, ſquare and large, ſuitable to their ſlow Motion, Food, and Abode; in others leſs, ſlender, and ſharp, agreeable to their ſwifter Motion, or to make their Way to their Food (*a*), or Habitation under Ground (*b*). But paſſing by a great many Obſervations that might be made of this Kind, I ſhall ſtop a little at the Brain, as the moſt conſiderable Part of this Part of the Body, being the great Inſtrument of Life and Motion in *Quadrupeds*, as it is in Man of that, as alſo in all Probability the chief Seat of his Immortal Soul. And accordingly it is a remarkable Difference, that in Man the Brain is large, affording Subſtance and Room for ſo noble a Gueſt; whereas in *Quadrupeds*, it is but ſmall. And another Thing, no leſs remarkable, is the Situation of the *Cerebrum* and *Cerebellum*,

(*a*) Thus *Swine*, for Inſtance, who dig in the Earth for Roots, and other Food, have their Neck, and all Parts of their Head very well adapted to that Service. Their Neck ſhort, brawny, and ſtrong; their Eyes ſet pretty high out of the Way; their Snout long; their Noſe callous and ſtrong; and their Senſe of Smelling very accurate, to hunt out and diſtinguiſh their Food in Mud, under Ground, and other the like Places where it lies concealed.

(*b*) What hath been ſaid of *Swine* is no leſs, rather more remarkable in the *Mole*, whoſe Neck, Noſe, Eyes and Ears, are all fitted, in the niceſt Manner, to its ſubterraneous Way of Life.

bellum, or the greater or leſſer Brain, which I ſhall give in the Words of one of the moſt exact Anatomiſts we have of that Part (*c*): "Since, ſaith he, "God hath given to Man a lofty Countenance, to "behold the Heavens, and hath alſo ſeated an im- "mortal Soul in the Brain, capable of the Con- "templation of Heavenly Things; therefore, as "his Face is erect, ſo the Brain is ſet in an higher "Place, namely, above the *Cerebellum*, and all "the Senſories. But in Brutes, whoſe Face is "prone towards the Earth, and whoſe Brain is ca- "pable of Speculation, the *Cerebellum*, (whoſe "Buſineſs it is to miniſter to the Actions and Func- "tions of the *Præcordia*, the principal Office in "thoſe Creatures) in them is ſituated in the higher "Place, and the *Cerebrum* lower. Alſo ſome of "the Organs of Senſe, as the Ears and Eyes, are "placed, if not above the *Cerebrum*, yet at leaſt "equal thereto.

Another Convenience in this Poſition of the *Cerebrum* and *Cerebellum*, the laſt ingenious Anatomiſt (*d*) tells us is this, "In the Head of Man, "ſaith he, the Baſe of the *Brain* and *Cerebell*, yea, "of the whole Skull, is ſet parallel to the Hori- "zon; by which Means there is the leſs Danger "of the two Brains joggling, or ſlipping out of "their Place. But in *Quadrupeds*, whoſe Head "hangs down, the Baſe of the Skull makes a right "Angle with the Horizon, by which Means the "Brain is undermoſt, and the *Cerebell* uppermoſt; "ſo

(*c*) *Willis Cereb. Anat.* cap. 6. *Cumque huic Deus os ſublime dederit, &c.*

(*d*) Id. paulo poſt. *In capite humano Cerebri & Cerebelli*, &c.

(*e*) See

"ſo that one would be apt to imagine the *Cere-*
"*bell* ſhould not be ſteady, but joggle out of its
"Place." To remedy which Inconvenience, he tells us, "And leſt the frequent Concuſſions of "the *Cerebell* ſhould cauſe a Fainting, or diſorder-"ly Motion of the Spirits about the *Præcordia*, "therefore, by the Artifice of Nature, ſufficient Pro-"viſion is made in all, by the *dura Meninx* cloſe-"ly encompaſſing the *Cerebellum*; beſides which, "it is (in ſome) guarded with a ſtrong bony Fence; "and in others, as the Hare, the Coney, and "ſuch leſſer *Quadrupeds*, a part of the *Cerebell* is "on each Side fenced with the *Os Petroſum*: "So that by this double Stay, its whole Maſs is "firmly contained within the Skull.

Beſides theſe Peculiarities, I might take notice of divers other Things no leſs remarkable, as the *Nictitating Membrane* of the Eye (*e*), the different Paſſages of the *Carotid Arteries* (*f*) through the Skull,

(*e*) See *Book* IV. *Chap.* 2. *Note* (*kk*).

(*f*) *Arteria Carotis aliquanto poſterius in homine quàm in alio quovis animali, Calvariam ingreditur, ſcil. juxta illud foramen, per quod ſinus lateralis in Venam jugularem deſiturus cranio elabitur; nam in cæteris hæc arteria ſub extremitate, ſeu proceſſu acuto oſſis petroſi, inter cranium emergit: verùm in capite humano, eadem, ambage longiori circumducta (ut ſanguinis torrens, priuſquam ad cerebri oram appellit, fracto impetu, leniùs & placidiùs fluat) prope ſpecum ab ingreſſu ſinûs lateralis factum, Calvariæ baſin attingit;* ——*& in majorem cautelam, tunicâ inſuper aſcititiâ craſſiore inveſtitur.* And ſo he goes on to ſhew the Conveniency of this Guard the Artery hath, and its Paſſage to the Brain, and then ſaith, *Si hujuſmodi conformationis ratio inquiritur, facilè occurrit, in capite humano, ubi generoſi affectus & magni animorum impetus ac ardores excitantur, ſanguinis in Cerebri oras appulſum debere eſſe liberum & expeditum, &c. Atque hoc quidem reſpectu differt Homo à pleriſque Brutis, quibus, Arteriæ in mille ſurculos diviſa, ne ſanguinem pleniore alveo, aut citatiore, quàm par eſt, curſu, ad cerebrum evehat, Plexus Retiformes conſtituit,*

Skull, their Branching into the *Rete Mirabile* (g), the different Magnitude of the *Nates*, and some other Parts of the Brain in Beasts, quite different from what it is in Man: But the Touches already given, may be Instances sufficient to prevent my being tedious in inlarging upon these admirable Works of God.

stituit, quibus nempe efficitur, ut sanguis tardo admodum, lenique & æquabili fere stillicidio, in cerebrum illabatur. And then he goes on to give a farther Account of this *Artery*, and the *Rete Mirabile* in divers Creatures. *Willis, ibid. c.* 8.

(g) *Galen* thinks the *Rete Mirabile* is for concocting and elaborating the Animal Spirits, as the *Epididymides*, [the Convolutions κειμενοειδῶς ἑλικῶν] are for elaborating the Seed. *De Us. Part. l.* 9. *c.* 4. This *Rete* is much more conspicuous in Beasts than Man; and, as Dr. *Willis* well judges, serves, 1. To bridle the too rapid Incursions of the Blood into the Brain of those Creatures, whose Heads hang down much. 2. To separate some of the superfluous serous Parts of the Blood, and send them to the Salival Glands, before the Blood enters the Brain of those Animals, whose Blood is naturally of a watery Constitution. 3. To obviate any Obstructions that may happen in the Arteries, by giving a free Passage through other Vessels, when some are stopped.

In *Quadrupeds*, as the *Carotid Arteries* are branched into the *Rete Mirabile*, for the bridling the too rapid Current of Blood into the Brain; so the *Vertebral Arteries*, are, near their Entrance into the Skull, bent into an acuter Angle than in Man, which is a wise Provision for the same Purpose.

CHAP. III.

Of the Necks of Quadrupeds.

FROM the Head pass we to the Neck, no principal Part of the Body, but yet a good Instance of the Creator's Wisdom and Design, inasmuch as in Man it is short, agreeable to the Erection

tion of his Body; but in the Four-footed Tribe it is long, answerable to the Length of the Legs (*a*), and in some of these long, and less strong, serving to carry the Mouth to the Ground; in others shorter, brawny and strong, serving to dig, and heave up great Burdens (*b*).

But that which deserves especial Remark, is that peculiar Provision made in the Necks of all, or most granivorous *Quadrupeds*, for the perpetual holding down their Head in gathering their Food, by that strong, tendinous and insensible *Aponeurosis*, or Ligament (*c*) braced from the Head to the middle of the Back. By which means the Head, although

(*a*) It is very remarkable, that in all the Species of *Quadrupeds*, this Equality holds, except only the *Elephant*; and that there should be a sufficient special Provision made for that Creature, by its *Proboscis* or *Trunk*. A Member so admirably contrived, so curiously wrought, and with so great Agility and Readiness, applied by that unweildy Creature to all its several Occasions, that I take it to be a manifest Instance of the Creator's Workmanship. See its Anatomy in Dr. *A. Moulen's Anat. of the* Elephant, *p.* 33. As also in Mr. *Blair's* Account in *Phil. Transf.* No. 326.

Aliorum ea est humilitas ut cibum terrestrem rostris facilè contingant. Quæ autem altiora sunt, ut Anseres, ut Cygni, ut Grues, ut Cameli, adjuvantur proceritate collorum. Manus etiam data Elephantis, qui propter magnitudinem corporis difficiles aditus habebant ad pastum. Cic. de N. D. l. 2. c. 47.

Quod iis animalibus quæ pedes habent fissos in digitos, Collum brevius sit factum, quàm ut per ipsum Cibum ori admovere queant: iis verò quæ ungulas habent solidas, aut bifidas, longius, ut prona atque inclinantia pasci queant. Qui id etiam opus non sit Artificis utilitatis memoris? Ad hæc quòd Grues ac Ciconiæ, cùm crura haberent longiora, ob eam causam Rostrum etiam magnum, & Collum longius habuerint. Pisces autem neque Collum penitus habuere, utpote qui neque Crura habent. Quo pacto non id etiam est admirandum? Galen. de Us. part. l. 11. c. 8.

(*b*) As in *Moles* and *Swine*, in *Ch.* 2. *Note* (*a*).

(*c*) Called the *Whiteleather*, *Packwax*, *Taxwax*, and *Fixfax*.

(*d*) The

though heavy, may be long held down without any Labour, Pain, or Uneaſineſs to the Muſcles of the Neck, that would otherwiſe be wearied by being ſo long put upon the Stretch.

CHAP. IV.

Of the Stomachs of Quadrupeds.

FROM the Neck, let us deſcend to the *Stomach*, a Part as of abſolute Neceſſity to the Being and Well-being of Animals, ſo is in the ſeveral Species of *Quadrupeds*, ſized, contrived, and made with the utmoſt Variety and Art. (*a*) What Artiſt, what Being, but the Infinite Conſervator of the World, could ſo well adapt every Food to all the ſeveral Kinds of thoſe grand Devourers of it! Who could ſo well ſute their Stomachs to the Reception and Digeſtion thereof; one kind of Stomach to the Carnivorous, another to the Herbaceous Animals; one fitted to digeſt by a bare Maſtication; and a whole Set of Stomachs in others, to digeſt with the Help of *Rumination!* Which laſt

(*a*) The peculiar Contrivance and Make of the *Dromedary's* or *Camel's* Stomach, is very remarkable, which I will give from the *Pariſian Anatomiſts: At the top of the Second* [of the 4 Ventricles] *there were ſeveral ſquare Holes, which were the Orifices of about* 30 *Cavities, made like Sacks placed between the two Membranes, which do compoſe the Subſtance of this Ventricle. The View of theſe Sacks made us to think that they might well be the Reſervatories, where* Pliny *ſaith, that Camels do a long Time keep the Water, which they drink in great Abundance——to ſupply the Wants thereof in the dry Deſarts*, &c. Vid. Memoirs, &c. Anat. of Dromedary, p. 39. See alſo *Peyer, Merycol. l.* 2. *c.* 3.

(*b*) Both

ſt Act, together with the *Apparatus* for that Ser-ice, is ſo peculiar, and withal ſo curious an Arti-ce of Nature, that it might juſtly deſerve a more articular Enquiry; but having formerly mentioned (*b*), and leſt I ſhould be too tedious, I ſhall paſs by.

(*b*) *Book* IV. *Chap.* 11.

CHAP. V.

Of the Hearts of Quadrupeds.

N this Part there is a notable Difference found between the Heart of Man and that of Beaſts, oncerning the latter, of which I might take No-ce of the remarkable Confirmation of the Hearts f Amphibious *Quadrupeds*, and their Difference om thoſe of Land-Animals, ſome having but one entricle (*a*), ſome three (*b*), and ſome but two ike Land-Animals but then the *Foramen Ovale* herewith (*c*). All which may be juſtly eſteemed as

(*a*) *Frogs* are generally thought to have but one Ventricle n their Hearts.

(*b*) The *Tortoiſe* hath three Ventricles, as the *Pariſian Aca-emiſts* in their *Memoirs* affirm. *Beſides theſe two Ventricles* [be-ore ſpoken of] *which were in the hinder Part of the Heart, which aceth the Spine; there was*, ſay they, *a third in the Fore-part, in-lining a little towards the Right-ſide*, &c. Memoirs, &c. p. 259. But Mr. *Buſſiere* charges this as a Miſtake in thoſe ingenious Gentlemen, and aſſerts there is but one Ventricle in the *Tor-oiſe*'s Heart. See his Deſcription of the Heart of the *Land-Tortoiſe*, in *Philoſ. Tranſact.* No. 328.

(*c*) The *Sea-Calf* is ſaid by the *French Academiſts*, to have his Proviſion, and their Account of it is this: *Its Heart was round and flat. Its Ventricles appeared very large, and its Auricles ſmall.*

as wonderful, as they are excellent Proviſions for the Manner of thoſe Animals living. But I ſhall content my ſelf with bare Hints of theſe Things, and ſpeak only of two Peculiars more, and that but briefly.

One is the Situation of the Heart, which in Beaſts is near the middle of the whole Body; in Man, nearer the Head (*d*). The Reaſons of which I ſhall give from one of the moſt curious Anatomiſts of that Part (*e*). "Seeing, ſaith he, the Trajection and Diſtribution of the Blood depends wholly on the Syſtole of the Heart, and that its Liquor is not driven of its own Nature ſo readily into the upper Parts as into Veſſels even with it, or downwards into thoſe under it: If the Situation of the Heart had been farther from the Head, it muſt needs either have been made ſtronger to caſt out its Liquor with greater Force; or elſe the Head would want its due Proportion of Blood. But in Animals that have a longer Neck, and which is extended towards their Food as it were, the Heart is ſeated as far from the other Parts; and they find no Inconvenience from it, becauſe they feed with their Head for the moſt part hanging down; and ſo the Blood, as it hath

"farther

ſmall.——*Underneath the great Aperture, through which the Trunk of the* Vena Cava *conveyed the Blood into the right Ventricle of the Heart, there was another, which penetrated into the* Arteria Venoſa, *and from thence into the left Ventricle, and afterwards into the* Aorta. *This Hole, called the* Foramen Ovale *in the* Fœtus, *makes the* Anaſtomoſis, *by the Means of which, the Blood goes from the* Cava *into the* Aorta, *without paſſing through the Lungs.* French Anatomiſts, *p.* 124.

(*d*) Τὴν τε Καρδίαν περὶ τὸ μέσον πλὴν ἐν Ἀνθρώπῳ, &c. *Ariſt. Hiſt. An. l.* 2. *c.* 17.

(*e*) Dr. *Lower, de Corde, c.* 1.

(*f*) I

" farther to go to their Head than in others, ſo it " goes a plainer and often a ſteep Way (*f*).

The other peculiar Matter is, the faſtning (I formerly mentioned) which the Cone of the *Pericordium* hath in Man to the *Diaphragm* (*g*), whereas in all *Quadrupeds* it is looſe. By which Means the Motion of the *Midriff*, in that neceſſary Act of Reſpiration, is aſſiſted both in the upright Poſture of Man, as alſo in the prone Poſture of *Quadrupeds* (*h*), which would be hindred, or rendred more Difficult, if the Caſe was otherwiſe: " Which " muſt needs be the Effect of Wiſdom and Deſign, " and that Man was intended by Nature to walk " erect, and not upon all-four, as *Quadrupeds* " do":

(*f*) I might have mentioned another wiſe Proviſion from the ſame Author, which take in his own Words: *In vitulis & Equis, imò plerique aliis animalibus majoribus, non ſolas propagines à Nervo ſexti paris ut in Homine, ſed etiam plurimas à Nervo intercoſtali, ubi rectà cor tranſit, cor accedere, imò in parenchyma ejus dimitti: & hoc ideo à Naturâ quaſi ſubſidium Brutis comparatum, ne capita quæ terram prona ſpectant, non ſatis facilè aut copiosè Spiritus Animales impertirent.* Blaſii Anat. Animal. Par. 1. c. 4. ex Lowero, de Corde.

(*g*) *Diaphragmatis circulo nerveo firmiter adhæret* [Pericordium] *quod Homini ſingulare; nam ab eo in Canibus & Simiis diſtat, item in aliis animalibus omnibus.* Bartholin. Anat. l. 2. c. 5.

(*h*) *Finalem cauſam quod attinet,* ——*cùm erectus ſit Hominis inceſſus atque figura, eoque faciliùs abdominis viſcera ſuo pondere deſcendant, minore Diaphragmatis nixu atque Syſtole ad Inſpirationem opus eſt: porrò, cùm in Exſpiratione pariter neceſſarium ſit Diaphragma relaxari,* ——*cùm capſula cordis omnino connectendum fuit, in Homine, ne fortè, quamdiu erectus incedit, ab Hepatis, aliorumque viſcerum appenſorum pondere deorſum adeò deprimeretur, ut neque Pulmo ſatis concidere, neque Exſpiratio debito modo peragi potuerit. Quocirca in Quadrupedibus, ubi abdominis viſcera in ipſum Diaphragma incumbunt, ipſumque in pectoris cavitatem ſuo pondere impellunt, iſta partium accretio Exſpirationi quidem inutilis, Inſpirationi autem debitam Diaphragmatis tenſionem impediendo, prorſus incommoda fuiſſet.* Lower, ib. p. 8.

(*i*) Dr.

"do": To express it in the Words of a great Judge in such Matters (*i*).

(*i*) Dr. Tyson's *Anatomy of the Orang-Outang*, in Ray's *Wisdom of God*, p. 262.

* * * \

Cervical Plexus to the Heart, and *Præcordia*. By which Means the Heart and Brain of Man have a mutual and very intimate Correſpondence and Concern with each other, more than is in other Creatures; or as one of the moſt curious Anatomiſts and Obſervers of theſe Things ſaith (*c*): "Brutes are as it were Machines made with a ſimpler, and leſs operoſe *Apparatus*, and endowed therefore with only one and the ſame Kind of Motion, or determined to do the ſame Thing: Whereas in Man, there is a great Variety of Motions and Actions. For by the Commerce of the aforeſaid *Cervical Plexus* (*d*) he ſaith, The Conceptions of the Brain preſently affect the Heart, and agitate its Veſſels and whole Appendage, together with the *Diaphragm*. From whence the Alteration in the Motion of the Blood, the Pulſe, and Reſpiration. So alſo on the contrary, when any Thing affects or alters the Heart, thoſe Impreſſions are not only retorted to the Brain by the ſame Duct of the Nerves, but alſo the Blood it ſelf (its Courſe being once changed)

ter officia ejus in imo ventre huic cum cæteris animalibus communia, etiam ante pectoris claustra internuncii specialis loco est, qui Cerebri & Cordis sensa mutua ultra citraque refert. Willis Nervor. descr. & usus, c. 26.

(*c*) Id. ib. *Dum hanc utriusque speciei differentiam perpendo, succurrit animo, Bruta esse velut machinas*, &c.

(*d*) That our great Man was not miſtaken, there is great Reaſon to imagine, from what he obſerv'd in diſſecting a Fool. Beſides the Brain being but ſmall, he ſaith, *Præcipua autem discriminis nota quam inter illius & viri cordati partes advertimus, hæcce erat; nempe quòd prædictus Nervi Intercostalis Plexus, quem Cerebri & Cordis internuncium & Hominis proprium diximus, in Stulto hoc valde exilis, & minori Nervorum satellitio stipatus fuerit.* Ibid.

(*e*) Id.

" changed) flies to the Brain with a different and " unuſual Courſe, and there agitating the Animal " Spirits with divers Impulſes, produceth various " Conceptions and Thoughts in the Mind." And he tells us, " That hence it was that the Ancient " Divines and Philoſophers too, made the Heart " the Seat of Wiſdom; and certainly (ſaith he) " the Works of Wiſdom and Virtue do very much " depend upon this Commerce which is between " the Heart and Brain:" And ſo he goeth on with more to the ſame Purpoſe. Upon the Account of this *Intercoſtal Commerce* with the Heart, being wanting in Brutes, there is another ſingularly careful and wiſe Proviſion the Infinite Creator hath made in them, and that is, That by Reaſon both the *Par Vagum*, and the *Intercoſtal* too, do not ſend their Branches to the Heart, and its Appendage in Brutes; therefore, leſt their Heart ſhould want a due Proportion of Nervous Veſſels, the *Par Vagum* ſends more Branches to their Heart than to that of Man. This, as it is a remarkable Difference between Rational and Irrational Creatures; ſo it is as remarkable an Argument of the Creator's Art and Care; who although he hath denied Brute-Animals Reaſon, and the Nerves miniſtring thereto, yet hath another Way ſupplied what is neceſſary to their Life and State. But let us hear the ſame great Author's Deſcant upon the Point (*e*); " Inaſmuch, ſaith he, as " Beaſts are void of Diſcretion, and but little ſub- " ject to various and different Paſſions, therefore " there was no Need that the Spirits, that were to

(*e*) Id. ib. cap. 29. *In quantum Beſtiæ prudentiâ carent, & variis diverſiſque paſſionibus, &c.*

" be

" be convey'd from the Brain to the *Præcordia*,
" ſhould paſs two different Ways, namely, one for
" the Service of the vital Functions, and another
" for the reciprocal Impreſſions of the Affections;
" but it was ſufficient that all their Spirits, what-
" ever Uſe they were deſigned for, ſhould be con-
" veyed one and the ſame Way.

Here now in the *Nervous Kind* we have manifeſt Acts of the Creator's Deſign and Wiſdom, in this ſo manifeſt and diſtinct a Proviſion for Rational and Irrational Creatures; and that *Man* was evidently intended to be the one, as the *Genus* of *Quadrupeds* was the other.

CHAP. VII.

The CONCLUSION.

AND now it is Time to pauſe a while, and reflect upon the Whole. And as from the Conſiderations in the preceding Book, we have eſpecial Reaſon to be thankful to our Infinitely Merciful Maker, for his no leſs Kind than Wonderful Contrivances of our Body; ſo we have Reaſon, from this brief View I have taken of this laſt Tribe of the Creation, to acknowledge and admire the Same Creator's Work and Contrivances in them. For we have here a large Family of Animals, in every particular Reſpect, curiouſly contrived and made, for that eſpecial Poſture, Place, Food, and Office or Buſineſs which they obtain in the World. So that if we conſider their own particular Happineſs and Good, or Man's Uſe and Service; or if we view

them throughout, and consider the Parts wherein they agree with Man, or those especially wherein they differ, we shall find all to be so far from being Things fortuitous, undesigned, or any Way accidental, that every Thing is done for the best; all wisely contrived, and incomparably fitted up, and every Way worthy of the Great Creator. And he that will shut his Eyes, and not see GOD (*a*) in these His Works, even of the poor Beasts of the Earth, that will not say [as *Elihu* hath it, *Job* xxxv. 10, 11.] *Where is God my Maker, who teacheth us more than the Beasts of the Earth, and maketh us wiser than the Fowls of the Heaven?* Of such an one we may use the Psalmist's Expression, *Psal.* xlxix. 12. That *he is like the Beasts* (*b*) *that perish.*

(*a*) ——*Deum namque ire per omnes*
Terrasque tractusque Maris, Cœlumque profundum.
Hinc Pecudes, Armenta, viros, genus omne Ferarum.
Virgil. Georg. l. 4.

(*b*) *Illos qui nullum omnino Deum esse dixerunt, non modò non Philosophos, sed ne homines quidem fuisse dixerim; qui, mutis simillimi, ex solo corpore constiterunt, nihil videntes animo.* Lactant. l. 7. c. 9.

BOOK VII.

A SURVEY *of* BIRDS.

HAVING briefly, as well as I could, dispatch'd the Tribe of *Quadrupeds*; I shall next take as brief and transient a View of the *Feather'd Tribe.*

And

And here we have another large Province to expatiate in, if we ſhould deſcend to every Thing wherein the Workmanſhip of the Almighty appears. But I muſt contract my *Survey* as much as may be; and ſhall therefore give only ſuch Hints and Touches upon this curious Family of Animals, as may ſerve for Samples of the reſt of what might be obſerv'd.

CHAP. I.

Of the Motion of Birds, and the Parts miniſtring thereto.

AS this Tribe hath a different Motion from that of other Animals, and an amphibious Way of Life; partly in the Air, and partly on the Land and Waters; ſo is their Body accordingly ſhap'd, and all their Parts incomparably fitted for that Way of Life and Motion; as will be found by a curſory View of ſome of the Particulars. And the

I. And moſt viſible Thing, is the Shape and Make of their Body, not thick and clumſy, but incomparably adapted to their Flight: Sharp before, to pierce and make Way through the Air, and then by gentle Degrees riſing to its full Bulk. To which we may add,

II. The neat Poſition of the *Feathers* throughout the Body; not ruffled, or diſcompoſed, or placed ſome this, ſome a contrary Way, according to the Method of Chance; but all artificially plac'd (*a*), for

(*a*) See before *Book* IV. *Chap.* 12. *Note* (*l*).

(*b*) Mr.

for facilitating the Motion of the Body, and its Security at the ſame Time, by way of Cloathing: And for that End, moſt of the Feathers tend backward, and are laid over one another in exact and regular Method, armed with warm and ſoft Down next the Body, and more ſtrongly made, and curiouſly clos'd next the Air and Weather, to fence off the Injuries thereof. To which Purpoſe, as alſo for the more eaſy and nimble gliding of the Body through the Air, the Proviſion Nature hath made, and the Inſtinct of theſe Animals to *preen* and *dreſs* their Feathers, is admirable; both in Reſpect of their Art and Curioſity in doing it, and the *Oil-bag* (*b*), Glands, and whole Apparatus for that Service.

III. And now having ſaid thus much relating to the Body's Motion, let us Survey the Grand Inſtrument thereof, the *Wings*. Which as they are principal Parts, ſo are made with great Skill, and placed in the moſt commodious Point of the Body (*c*), to

(*b*) Mr. *Willughby* ſaith, there are two Glands for the Secretion of the unctuous Matter in the *Oil-bag*. And ſo they appear to be in Geeſe. But upon Examination, I find, that in moſt other Birds, (ſuch at leaſt as I have enquired into,) there is only one Gland; in which are divers little Cells, ending in two or three larger Cells, lying under the Nipple of the *Oil-bag*. This *Nipple* is perforated, and being preſſed, or drawn by the Bird's-Bill, or Head, emits the liquid Oil, as it is in ſome Birds, or thicker unctuous Greaſe, as it is in others. The whole *Oil-bag* is in its Structure ſomewhat conformable to the Breaſts of ſuch Animals as afford Milk.

(*c*) In all Birds that fly much, or that have the moſt Occaſion for their Wings, it is manifeſt that their Wings are plac'd in the very beſt Part, to balance their Body in the Air, and to give as ſwift a Progreſſion, as their Wings and Body are capable of: For otherwiſe we ſhould perceive them to reel, and fly unſteadily; as we ſee them to do, if we alter their Æquipoiſe,

to give it in an exact Equipoiſe in that ſubtile Medium, the Air.

And here it is obſervable, with what incomparable Curioſity every Feather is made; the *Shaft* exceeding ſtrong, but hollow below, for Strength and Lightneſs Sake; and above, not much leſs ſtrong, and fill'd with a *Parenchyma* or *Pith*, both ſtrong and light too. The *Vanes* as nicely gaug'd on each Side as made; broad on one Side, and narrower on the other; both which incomparably miniſter to the progreſſive Motion of the Bird, as alſo to the Union and Cloſeneſs of the Wing (*d*).

And

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poiſe, by cutting the End of one of the Wings, or hanging a Weight at any of the extreme Parts of the Body. But as for ſuch Birds as have as much Occaſion for Swimming as Flying, and whoſe Wings are therefore ſet a little out of the Centre of the Body's Gravity. See *Book* IV. *Chap.* 8. *Note* (*q*). And for ſuch as have more Occaſion for Diving than Flying, and whoſe Legs are, for that Reaſon, ſet more backward, and their Wings more forward. *Chap.* 4. *Note* (*k*) of this *Book*.

(*d*) The Wiſe Author of Nature hath afforded an Example of the great Nicety in the Formation of Birds, by the Nicety obſerved in a Part no more conſiderable than the Vanes of the Flag-feathers of the Wing. Among others, theſe two Things are obſervable: 1. The Edges of the exterior or narrow Vanes bend downwards, but of the interior wider Vanes upwards; by which Means they catch, hold, and lie cloſe to one another, when the Wing is ſpread; ſo that not one Feather may miſs its full Force and Impulſe upon the Air. 2. A yet leſſer Nicety is obſerv'd, and that is, in the very ſloping the Tips of the Flag-feathers: The interiour Vanes being neatly ſlop'd away to a Point, towards the outward Part of the Wing; and the exteriour Vanes ſlop'd towards the Body, at leaſt in many Birds; and in the Middle of the Wing, the Vanes being equal, are but little ſlop'd. So that the Wing, whether extended or ſhut, is as neatly ſlop'd and form'd, as if conſtantly trimm'd with a Pair of Sciſſors.

And no leſs exquiſite is the textrine Art of the *Plumage* (*e*) alſo; which is ſo curiouſly wrought, and ſo artificially interwoven, that it cannot be viewed without Admiration, eſpecially when the Eye is aſſiſted with Glaſſes.

And as curiouſly made, ſo no leſs curiouſly are the Feathers placed in the Wing, exactly according to their ſeveral Lengths and Strength: The *Principals* ſet for Stay and Strength, and theſe again

(*e*) Since no exact Account, that I know of, hath been given of the Mechaniſm of the *Vanes*, or *Webs* of the Feathers, my Obſervations may not be unacceptable. The *Vane* conſiſts not of one continu'd Membrane; becauſe if one broken, it would hardly be reparable: But of many *Laminæ*, which are thin, ſtiff, and ſomewhat of the Nature of a thin Quill. Towards the Shaft of the Feather, (eſpecially in the Flag-feathers of the Wing,) thoſe *Laminæ* are broad, &c. of a ſemicircular Form; which ſerve for Strength, and for the cloſer ſhutting of the *Laminæ* to one another, when Impulſes are made upon the Air. Towards the outward Part of the Vane, theſe *Laminæ* grow ſlender and taper: On their under Side they are thin and ſmooth, but their upper-outer Edge is parted into two hairy Edges, each Side having a different Sort of Hairs, laminated or broad at Bottom, and ſlender and bearded above the other half. I have, as well as I could, repreſented the uppermoſt Edge of one of theſe *Laminæ* in *Fig.* 18. with ſome of the Hairs on each Side, magnify'd with a Microſcope. Theſe bearded Briſtles, or Hairs, on one Side the *Laminæ*, have ſtrait Beards, as in *Fig.* 19. thoſe on the other Side, have hook'd Beards on one Side the ſlender Part of the Briſtle, and ſtrait ones on the other, as in *Fig.* 20. Both theſe Sorts of Briſtles magnify'd, (only ſcattering, and not cloſe,) are repreſented as they grow upon the upper Edge of the *Lamina ſ. t.* in *Fig.* 18. And in the Vane, the hook'd Beards of one *Lamina*, always lie next the ſtrait Beards of the next *Lamina*; and by that Means lock and hold each other; and by a pretty Mechaniſm, brace the *Laminæ* cloſe to one another. And if at any Time the Vane happens to be ruffled and diſcompos'd, it can by this pretty eaſy Mechaniſm, be reduc'd and repair'd. *Vid. Book* IV. *Chap.* 12. *Note* (*m*).

(*f*) *Peſſo-*

gain well lined, faced, and guarded with the *Covert* and *Secondary Feathers*, to keep the Air from paſſing through, whereby the ſtronger Impulſes are made thereupon.

And laſtly, to ſay no more of this Part, that deſerves more to be ſaid of it, what an admirable *Apparatus* is there of *Bones*, very ſtrong, but withal light and incomparably wrought? of *Joynts*, which open, ſhut, and every way move, according to the Occaſions either of extending it in Flight, or withdrawing the Wing again to the Body? And of various *Muſcles*; among which the peculiar Strength of the *Pectoral Muſcles* deſerves eſpecial Remark, by Reaſon they are much ſtronger (*f*) in Birds than in Man, or any other Animal, not made for Flying.

IV. Next the Wings, the Tail is in Flight conſiderable; greatly aſſiſting in all Aſcents and Deſcents in the Air, as alſo ſerving to ſteady (*g*) Flight,

(*f*) *Pectorales Muſculi Hominis flectentes humeros, parvi & parum carnoſi ſunt; non æquant 50am aut 70am partem omnium Muſculorum Hominis. E contra in Avibus, Pectorales Muſculi vaſtiſſimi ſunt, & æquant, imò excedunt, & magis pendent, quàm reliqui omnes Muſculi ejuſdem Avis ſimul ſumpti.* Borell. de Mot. Animal. Vol. I. Prop. 184.

Mr. *Willughby* having made the like Obſervation, hath this Reflection on it, *whence, if it be poſſible for a Man to fly, it is thought by them who have curiouſly weighed and conſidered the matter, that he that would attempt ſuch a Thing with Hopes of Succeſs, muſt ſo contrive and adapt his Wings, that he may make uſe of his Legs, and not his Arms in managing them:* (becauſe the Muſcles of the Legs are ſtronger, as he obſerves.) Willugh. Ornith. l. 1. c. 1. ſect. 19.

(*g*) Mr. *Willughby*, *Ray*, and many others, imagine the principal Uſe of the Tail to be to ſteer, and turn the Body in the Air, as a Rudder. But *Borelli* hath put it beyond all Doubt, that this is the leaſt Uſe of it, and that it is chiefly to

Flight, by keeping the Body upright in that ſubtile and yielding *Medium*, by its readily turning and anſwering every Vacillation of the Body.

And now to the Parts ſerving to Flight, let us add the nice and compleat Manner of its Performance; all done according to the ſtricteſt Rules of Mechaniſm (*h*). What Rower on the Waters, what Artiſt on the Land, what acuteſt Mathematician could give a more agreeable and exact Motion to the Wings, than theſe untaught flying Artiſts do theirs! Serving not only to bear their Bodies up in the Air, but alſo to waft them along therein, with a ſpeedy progreſſive Motion, as alſo to ſteer and turn them this Way and that Way, up and down, faſter or ſlower, as their Occaſions require, or their Pleaſure leads them.

V. Next to the Parts for Flight, let us view the *Feet* and *Legs* miniſtring to their other Motion: Both made light, for eaſier Tranſportation through the Air; and the former ſpread, ſome with Membranes for Swimming (*i*), ſome without, for ſteady Going,

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aſſiſt the Bird in its Aſcents and Deſcents in the Air, and to obviate the Vacillations of the Body and Wings. For as for turning to this or that Side, it is performed by the Wings and Inclination of the Body, and but very little by the help of the Tail.

(*h*) See *Borelli ubi ſupr.* Prop. 182, *&c.*

(*i*) It is conſiderable in all Water-Fowl, how exactly their Legs and Feet correſpond to that way of Life. For either their Legs are long, to enable them to wade in the Waters: In which caſe, their Legs are bare of Feathers a good way above the Knees, the more conveniently for this Purpoſe. Their Toes alſo are all abroad; and in ſuch as bear the Name of *Mudſuckers*, two of the Toes are ſomewhat joined, that they may not eaſily ſink in walking upon boggy Places. And as for ſuch as are whole-footed, or whoſe Toes are webbed

Going, for Perching, for Catching and Holding of Prey (*k*), or for Hanging by the Heels to gather their Food (*l*), or to fix themſelves in their Places of Retreat and Safety. And the latter, namely the *Legs*, all curved for their eaſy Perching, Rooſting, and Reſt, as alſo to help them upon their Wings in taking their Flight, and to be therein commodiouſly tucked up to the Body, ſo as not to obſtruct their Flight. In ſome long, for Wading and Searching the Waters; in ſome of a moderate Length, anſwerable to their vulgar Occaſions; and in others as remarkably ſhort, to anſwer their eſpecial Occaſions and Manner of Life (*m*). To all theſe let us add the placing theſe laſt mentioned

webbed together (excepting ſome few) their Legs are generally ſhort, which is the moſt convenient Size for Swimming. And 'tis pretty enough to ſee how artificially they gather up their Toes and Feet when they withdraw their Legs, or go to take their Stroke; and as artificially again extend or open their whole Foot, when they preſs upon, or drive themſelves forward in the Waters.

(*k*) Some of the Characteriſticks of Rapacious Birds, are, *to have hooked, ſtrong, and ſharp-pointed Beaks and Talons, fitted for Rapine, and tearing of Fleſh; and ſtrong and brawny Thighs, for ſtriking down their Prey.* Willughby Ornith. l. 2. c. 1. Raii Synopſ. Av. Method. p. 1.

(*l*) Such Birds as climb, particularly thoſe of the *Wood-pecker* Kind, have for this Purpoſe (as Mr. *Willughby* obſerves, l. 2. c. 4.) 1. Strong and muſculous Thighs. 2. Short Legs and very ſtrong. 3. Toes ſtanding two forwards and two backwards. Their Toes alſo are cloſe joined together, that they may more ſtrongly and firmly lay hold on the Tree they climb upon. 4. All of them——have a hard ſtiff Tail bending alſo downwards, on which they lean, and ſo bear up themſelves in climbing.

(*m*) *Swifts* and *Swallows* have remarkably ſhort Legs eſpecially the former, and their Toes graſp any Thing very ſtrongly. All which is uſeful to them in building their Neſts, and other ſuch Occaſions as neceſſitate them to hang frequently

tioned Parts in the Body. In all ſomewhat out of the Centre of the Body's Gravity (*n*), but in ſuch as ſwim, more than in others, for the better rowing their Bodies through the Waters, or to help them in that Diving (*o*) too.

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quently by their Heels. But there is far greater Uſe of this Structure of their Legs and Feet, if the Reports be true of their hanging by the Heels in great Cluſters (after the manner of Bees) in Mines and Grotto's, and on the Rocks by the Sea, all the Winter. Of which latter, I remember the late learned Dr. *Fry* told this Story at the Univerſity, and confirmed it to me ſince, *viz.* That an ancient Fiſherman, accounted an honeſt Man, being near ſome Rocks on the Coaſt of *Cornwal*, ſaw at a very low Ebb, a black Liſt of ſomething adhering to the Rock, which when he came to examine, he found it was a great Number of *Swallows*, and, if I miſremember not, of *Swifts* alſo, hanging by the Feet to one another, as Bees do; which were covered commonly by the Sea-Waters, but revived in his warm Hand, and by the Fire. All this the Fiſherman himſelf aſſured the Doctor of. Of this, ſee more, *Chap.* 3. *Note* (*d*) of this Book.

(*n*) In Birds that frequent not the Waters, the Wings are in the Center of Gravity, when the Bird lies along, as in Flying; but when it ſtands or walks, the Erection of the Body throws the Center of Gravity upon the Thighs and Feet.

(*o*) See *Chap.* 4. *Note* (*k*).

CHAP. II.

Of the Head, Stomach, and other Parts of BIRDS.

THUS having diſpatched the Parts principally concerned in the Motion of the *Feather'd Tribe*, let us proceed to ſome other Parts not yet animadverted upon. And we will begin with the *Head*, concerning which I have already taken notice

ice of its Shape for making way through the Air; of the Make of the *Bill*, for gathering Food, and other Uſes; the commodious Situation of the *Eye*; and I might add that of the *Ear* too, which would be in the Way, and obſtruct Flight, if 'twas like that of moſt other Animals: Alſo I might ſay a great deal of the Conformation of the *Brain*, and of the Parts therein wanting, and of others added, like to what is obſervable in Fiſhes; whoſe Poſture in the Waters reſembles that of Birds in the Air (*a*), and both very different from Man and Beaſts; and laſtly, to hint at no more, I might ſurvey the peculiar Structure of the *Larynx* (*b*), the *Tongue*,

(*a*) *Cerebra Hominum & Quadrupedum in pleriſque ſimilia exiſtunt. ——Capitibus Volucrum & Piſcium contenta, ab utriſque prioribus longè diverſa, tamen inter ſe, quoad præcipuas ἐγκεφάλου partes Symbola reperiuntur.* The Particulars wherein the Brains of Birds and Fiſhes agree with one another, and wherein they differ from the Brain of Man and Beaſts, ſee in the ſame juſtly famous Author, *Willis Cereb. Anat. c.* 5.

(*b*) *Circa bifurcationem Aſperæ Arteriæ, elegans Artificis liberè agentis indicium detegitur ex Avium comparatione cum Quadrupedibus: cum Vocis gratia in diverſis Avibus diverſam muſculorum fabricam bifurcationi Aſperæ Arteriæ dederit, quorum nullum veſtigium extat in Homine & Quadrupedibus mihi viſis, ubi omnes vocis muſculos capiti Arteriæ junxit. In Aquilâ, &c. ſupra bifurcationem, &c.* Steno in Blaſ. Anat. Animal. p. 2. c. 4.

The *Aſpera Arteria* is very remarkable in the *Swan*, which is thus deſcribed by *T. Bartholin*, viz. *Aſpera Arteria admirandæ ſatis ſtructuræ. Nam pro Colli longitudine deorſum Oeſophagi comes protenditur donec ad ſternum perveniat, in cujus capſulam ſe incurvo flexu inſinuat & recondit, velut in tuto loco & thecâ, moxque ad fundum ejuſdem cavitatis delata ſurſum reflectitur, egrediturque anguſtias Sterni, & Claviculis mediis concenſis, quibus ut fulcro nititur, ad Thoracem ſe flectit——Miranda hercle modis omnibus conſtitutio & Reſpirationi inſervit & Voci. Nam cùm in ſtagnorum fundo edulia pro victu quærat, longiſſimo indiguit collo, ne longa mora ſuffocationis incurreret periculum. Et certè dum dimidiam fere horam toto Capite & Collo pronis vado immergiter, pedibus in altum elatis cœloque obverſis, ex eâ*

Arteriæ

Tongue (*c*), the inner Ear (*d*), and many Matters besides;

Arteria quæ pectoris dicta vagina recluſa eſt portione, tanquam e cendo promo ſpiritum haurit. Blaſ. ib. c. 10.

(*c*) The Structure of the *Tongue* of the *Wood-Pecker* is very ſingular and remarkable, whether we look at its great Length, its Bones and Muſcles, its encompaſſing Part of the Neck and Head, the better to exert it ſelf in Length; and again, to retract it into its Cell; and laſtly, whether we look at its ſharp, horny, bearded Point, and the glewy Matter at the End of it, the better to ſtab, to ſtick unto, and draw out little Maggots out of Wood. *Utilis enim Picis* (ſaith Coiter) *ad Vermiculos, Formicas, aliaque Inſecta venanda talis Lingua foret. Siquidem Picus, innata ſuâ ſagacitate cùm deprehendit alibi in arboribus, vel carie, vel aliâ de causâ cavatis, Vermes inſectaque latiteſcere, ad illas volitat, ſeſeque digitis, unguliſque poſterioribus robuſtiſſimis, & Cauda pennis rigidiſſimis ſuſtentat, donec valido ac pervio Roſtro arborem pertundat: arbore pertusâ, foramini roſtrum immittit, ac quo animacula ſtridore excitet percellatque, magnam in arboris cava emittit vocem, inſecta vociferatione hâc concitata huc illucque repunt; Picus* v. *linguam ſuam exerit, atque aculeis, hamiſque animalia infigit, infixa attrahit & devorat.* Vid. Blaſii ubi ſupra, p. 2. c. 24.

(*d*) I have before in *Book* IV. *Chap.* 3. *Note* (*u*), taken notice of what others have obſerved concerning the *inner Ear* of *Birds*, reſerving my own Obſervations for this Place: Which I hope may be acceptable, not only for being ſome of them new, but alſo ſhewing the Mechaniſm of Hearing in General.

In this Organ of Birds, I ſhall take notice only of three Parts, the *Membranes* and *Cartilages*; the *Columella*; and the *Conclave*: The *Drum*, as ſome call it, or *Membrana Tympani*, as others, conſiſts of two Membranes, the Outer, which covers the whole *Meatus*, Baſon or *Drum*, (as ſome call it) and the inner Membrane. To ſupport, diſtend and relax the outermoſt, there is one ſingle Cartilage, reaching from the Side of the *Meatus*, to near the middle of the Membrane. On the top of the *Columella* is another Cartilage, conſiſting of three Branches, *a. b. c.* in *Fig.* 23. The longeſt middle Branch *a.* is joined to the top of the ſingle upper Cartilage before ſpoken of, and aſſiſts it to bear up the upper-outer Membrane: The two Branches, *b. c.* are joined to the *Os Petroſum*, at ſome Diſtance from the outer Membrane: Upon this inner Cartilage, is the inner Membrane fixed, the two outer Sides of which *a. b.* and *a. c.* are joined to the outer Membrane, and made a kind of three-ſquare Bag. The

Deſign

Design of the two Branches or Legs of the Cartilage, *b. c.* are, I conceive, to keep the *Cartilage* and *Columella* from wavering Side-ways, and to hinder them from flying too much back: There is a very fine ſlender Ligament extended from the oppoſite Side, quite croſs the *Meatus* or Baſon, to the Bottom of the *Cartilage*, near its joining to the *Columella*. Thus much for the *Membrana Tympani*, and their *Cartilages*.

The next Part is the *Columella* (as *Schelhammer* calls it.) This is a very fine, thin, light, bony Tube; the Bottom of which ſpreads about, and gives it the Reſemblance of a wooden Pot-lid, ſuch as I have ſeen in Country-Houſes. It exactly puts into, and covers a *Foramen* of the *Conclave*, to which it is braced all round, with a fine ſubtile Membrane, compoſed of the tender Auditory Nerve. This Bottom or Baſe of the *Columella*, I call the *Operculum*.

The laſt Part, which ſome call the *Labyrinth* and *Cochleæ*, conſiſting of Branches more like the *Canales Semicirculares* in Man, than the *Cochleæ*, I call the *Conclave Auditûs*. It is (as in moſt other Animals) made of hard context Bone. In moſt of the Birds I have opened, there are *circular Canals*, ſome larger, ſome leſſer, croſſing one another at right Angles, which open into the *Conclave*. But in the *Gooſe* it is otherwiſe, there being cochleous Canals, but not like thoſe of other Birds. In the *Conclave*, at the Side oppoſite to the *Operculum*, the tender Part of the *Auditory Nerve* enters, and lineth all thoſe inner retired Parts, *viz.* the *Conclave* and *Canals*.

As to the *Paſſages*, *Columnæ*, and other Parts obſervable in the Ear of Birds, I ſhall paſs them by, it being ſufficient to my Purpoſe, to have deſcribed the Parts principally concerned in the Act of Hearing. And as the Ear is in Birds the moſt ſimple and incomplex of any Animals Ear; ſo we may from it make an eaſy and rational Judgment, how *Hearing* is performed, *viz.* *Sound* being a *Tremor*, or *Undulation* in the Air, cauſed by the Colliſion of Bodies, doth, as it moves along, ſtrike upon the *Drum*, or *Membrana Tympani* of the Ear. Which Motion, whether ſtrong or languid, ſhrill, or ſoft, tuneful or not, is at the ſame Inſtant impreſſed upon the *Cartilages*, *Columella*, and *Operculum*, and ſo communicated to the *Auditory Nerve* in the *Conclave*.

And now if we compare the Organ and Act of Hearing, with thoſe of Sight, we ſhall find that the *Conclave* is to Hearing, as the *Retina* is to Sight; that ſonorous Bodies make their Impreſſions thereby on the Brain, as viſible Objects do by the *Retina*. Alſo, that as there is an *Apparatus* in the Eye, by the opening and ſhutting of the Pupil, to make it corre-

ſpond

beſides; but for a Sample, I ſhall only inſiſt upon the wonderful Proviſion in the Bill for the judging of the Food, and that is by peculiar Nerves lodged therein for that Purpoſe; ſmall and leſs numerous in ſuch as have the Aſſiſtance of another Senſe, the Eye; but large, more numerous, and thickly branched about, to the very End of the Beak, in ſuch as hunt for their Food out of Sight in the Waters, in Mud, or under Ground (*e*). And

ſpond to all the Degrees of Light, ſo there is in the Ear, to make it conformable to all the Degrees of Sound, a noble Train of little Bones and Muſcles in Man, &c. to ſtrain and relax the Membrane, and at the ſame Time to open and ſhut the *Baſis* of the *Stapes* (the ſame as what I call the *Operculum* in Birds:) But in Birds there is a more ſimple, but ſufficient *Apparatus* for this Purpoſe, tender Cartilages, inſtead of Bones and Joints, to correſpond to the various Impreſſions of Sounds, and to open and ſhut the *Operculum*. Beſides which, I ſuſpect the Ligament I mention'd, is only the Tendon of a Muſcle, reaching to the inner *Membrana Tympani*, and joined thereto (as I find by a ſtricter Scrutiny) and not to the Cartilage, as I imagined. By this Muſcle, the inner Membrane, and by Means of that the Outer alſo, can be diſtended or relaxed, as it is in Man, by the *Malleus* and its Muſcle, &c.

(*e*) *Flat-billed Birds, that grope for their Meat, have three Pair of Nerves, that come into their Bills, whereby they have that Accuracy to diſtinguiſh what is proper for Food, and what to be rejected by their Taſte, when they do not ſee it. This was moſt evident in a Duck's Bill and Head; Ducks having larger Nerves that come into their Bills than Geeſe, or any other Bird that I have ſeen; and therefore quaffer and grope out their Meat the moſt. But then I diſcovered none of theſe Nerves in round-bill'd Birds. But ſince, in my Anatomies in the Country, in a Rook, I firſt obſerved two Nerves that came down betwixt the Eyes into the upper Bill, but conſiderably ſmaller than any of the three Pair of Nerves in the Bills of Ducks, but larger than the Nerves in any other round-bill'd Birds. And it is remarkable that theſe Birds, move than any other round-bill'd Birds, ſeem to Grope for their Meat in Cow-dung*, &c. *Mr.* J. Clayton, *in* Philoſ. Tranſ. No. 206.

I obſerv'd three Pair of Nerves in all the broad-bill'd Birds that I could meet with, and in all ſuch as feel for their Food out of Sight, as Snipes, Woodcocks, Curlews, Geeſe, Ducks, Teals, Widgeons, &c. *Theſe*

And now from the Head and Mouth, paſs we to its near Ally, the Stomach, another no leſs notable than uſeful Part; whether we conſider the Elegancy of its Fibres and Muſcles, or its Multiplicity; one to ſoften and macerate, another to digeſt; or its Variety, ſuited to various Foods, ſome membranous, agreeable to the frugivorous, or carnivorous Kind; ſome muſculous and ſtrong (*f*), ſuited to the Comminution, and grinding of Corn and Grain, and ſo to ſupply the Defect of Teeth.

And now to this Specimen of the Parts, I might add many other Things, no leſs curiouſly contriv'd, made and ſuited to the Occaſions of theſe Volatiles; as particularly the Structure and Lodgment of the *Lungs* (*g*); the Configuration of the *Breaſt*,

Theſe Nerves are very large, equalling almoſt the Optic Nerve in Thickneſs.——Two are diſtributed nigh the End of the upper Bill, and are there very much expanded, paſſing through the Bone into the Membrane, lining the Roof of the Mouth. Dr. *A. Moulen*, Ibid. No. 199. Or both in Mr. *Lowthorp*'s Abridg. v. 2. p. 861, 862.

(*f*) The *Gizzard* is not only made very ſtrong, eſpecially in the Granivorous; but hath alſo a Faculty of Grinding what is therein. For which Purpoſe, the Bird ſwalloweth rough Stones down, which when grown ſmooth, are rejected and caſt out of the Stomach, as uſeleſs. This Grinding may be heard in Falcons, Eagles, &c. by laying the Ear cloſe to them, when their Stomachs are empty, as the famous Dr. *Harvey* ſaith. *De Generat. Exer.* 7.

As to the Strength of the *Gizzard*, and the Uſe of Stones to the Digeſtion of Fowls, divers curious Experiments may be met with, try'd by *Seigneur Redi*, with Glaſs-Bubbles, ſolid Glaſs, Diamonds, and other hard Bodies. See his *Exp. Nat.*

(*g*) It is no leſs remarkable in Birds, that their *Lungs* adhere to the *Thorax*, and have but little Play, than that in other Animals they are looſe, and play much, which is a good Proviſion for their ſteady Flight. Alſo they want the *Diaphragm*, and inſtead thereof, have divers large Bladders made of thin tranſparent Membranes, with pretty large Holes out of one into the other. Theſe Membranes ſeem to me to ſerve for

Breaſt, and its Bone, made like a Keel, for commodious Paſſage through the Air, to bear the large and ſtrong Muſcles, which move the Wings, and to counterpoiſe the Body, and ſupport and reſt it upon at Rooſt. The *Neck* alſo might deſerve our Notice, always either exactly proportion'd to the Length of the Legs, or elſe longer, to hunt out Food, to ſearch in the Waters (*h*); as alſo to counterpoiſe the Body in Flight (*i*). And laſtly, I might here take Notice of the Defect of the Diaphragm, ſo

for *Ligaments*, or *Braces* to the *Viſcera*, as well as to contain Air. Towards the upper Part, each Lobe of the Lungs is perforated in two Places, with large Perforation; whereof one is towards the outer, the other towards the inner Part of the Lobe. Through theſe Perforations, the Air hath a Paſſage into the Belly, (as in *Book* I. *Chap.* 1. *Note* (*b*);) that is, into the foremention'd Bladders; ſo that by blowing into the *Aſpera Arteria*, the Lungs will be a little rais'd, and the whole Belly blown up, ſo as to be very turgid. Which doubtleſs is a Means to make their Bodies more or leſs buoyant, according as they take in more or leſs Air, to facilitate thereby their Aſcents, and Deſcents: Like as it is in the *Air-bladders* of Fiſhes, in the laſt cited Place, *Note* (*i*).

(*h*) *Such Birds as have long Legs, have alſo a long Neck; for that otherwiſe they could not commodiouſly gather up their Food, either on Land, or in the Water. But on the other Side, thoſe which have long Necks, have not always long Legs, as in Swans——whoſe Necks ſerve them to reach to the Bottom of Rivers*, &c. Willughby's Ornithol. l. 1. c. 1. ſect. 7.

(*i*) We have ſufficient Inſtances of this in *Geeſe*, *Ducks*, &c. whoſe Wings, (their Bodies being made for the Convenience of Swimming,) are placed out of the Centre of Gravity, nearer the Head. But the extending the Neck and Head in Flight, cauſeth a due Æquipoiſe and Libration of the Body upon the Wings; which is another excellent Uſe of the long Necks of theſe Birds, beſides that of reaching and ſearching in the Waters for their Food.

But in the *Heron*, whoſe Head and long Neck, (although tuck'd up in Flight,) overbalance the hinder Part of the Body; the long Legs are extended in Flight, to counterpoiſe the Body, as well as to ſupply what is wanting in the Tail, from the Shortneſs of it.

(*k*) *Stern*

ſo neceſſary in other Animals to Reſpiration; and alſo of divers other Parts redundant, defective, or varying from other Animals. But it would be tedious to inſiſt upon all; and therefore to the Examples already given, I would rather recommend a nice Inſpection (*k*), of thoſe curious Works of God, which would be manifeſt Demonſtrations of the admirable Contrivance and Oeconomy of the Bodies of thoſe Creatures.

From the Fabrick therefore of their Bodies, I ſhall paſs to a Glance of one or Two Things, relating to their *State*; and ſo conclude this Genus of the Animal World.

(*k*) *Steno* thus concludes his Myology of the Eagle, *Imperfecta hæc Muſculorum deſcriptio, non minùs arida eſt Legentibus, quàm Inſpectantibus fuerit jucunda eorundem præparatio. Elegantiſſima enim Mechanices artificia, creberrimè in illis obvia, verbis non niſi obſcurè exprimuntur, carnium autem ductu, tendinum colore, inſertionum proportione, & trochlearum diſtributione oculis expoſita omnem ſuperant admirationem.* Steno in Blaſ. Anat. Animal. p. 2. c. 4.

CHAP. III.

Of the Migration of BIRDS.

CONcerning the *State* of this Tribe of *Animals*, the firſt Thing I ſhall ſpeak of, (by Reaſon God himſelf inſtanceth in it,) ſhall be their Migration, mention'd, *Jer.* viii. 7. *Yea, the Stork in the Heaven knoweth her appointed Times, and the Turtle, and the Crane, and the Swallow obſerve the Time of their Coming; but my People,* &c.

In which Act of Migration, there are two Things to me exceedingly notable. One is what the Text ſpeaks of, their knowing their proper Times for their *Paſſage*, when to come (*a*), when to go; as alſo that ſome ſhould come when others go; and ſome others go when theſe come. There is no doubt but the Temperature of the Air, as to Heat and Cold, and their natural Propenſity to breed their Young, may be great Incentives to thoſe Creatures to change their Habitation: But yet it is a very odd Inſtinct, that they ſhould at all ſhift their Habitation; that ſome certain Place is not to be found in all the Terraqueous Globe, affording them convenient Food and Habitation all the Year, either in the colder Climes, for ſuch as delight in the colder Regions; or the hotter, for ſuch *Birds of Paſſage* as fly to us in Summer.

Alſo it is ſomewhat ſtrange, that thoſe untaught, unthinking Creatures, ſhould ſo exactly know the beſt and only proper Seaſons to go and come. This gives us good Reaſon to interpret the מועדיה *appointed Times* (*b*), in the Text, to be ſuch Times as the Creator hath appointed thoſe Animals, and hath accordingly, for this End, imprinted upon their Natures ſuch an Inſtinct, as exciteth and moveth them

(*a*) *Curioſa res eſt, ſcire, quàm exactè hoc genus avium* [Gruum] *quotannis obſervet tempora ſui reditûs ad nos. Anno* 1667, *primæ Grues comparuerunt in campeſtribus Piſæ* 20 *Feb. &c.* F. Redi Exp. Nat. p. 100. ubi plura.

(*b*) From יעד *indixit, conſtituit, ſcil. locum, vel tempus, ubi et quando aliquid fieri debet.* Buxt. in verb.

De voluntate ſuâ certiorem reddidit. Con. Kircher concordant. Pars. 1. Col. 1846. מועד *Generaliter pro re aliquâ certâ, atteſtatâ, & definitâ accipitur.* 1. *Pro tempore certo & conſtituto.* 2. *Deinde pro feſto ſeu Solennitate, quæ certo & ſtato tempore celebratur.* 3. *Pro loco certo conſtituto.* Id. Ibid. Col. 1847.

(*c*) *Quis*

them this, at proper Times, to fly from a Place that would obſtruct their Generation, or not afford convenient Food for them, and their Young, and betake themſelves to another Place, affording all that is wanting for Food or Incubation.

And this leads me to another Thing remarkable in this Act of Migration; and that is, That thoſe unthinking Creatures ſhould know what Way to ſteer their Courſe (*c*), and whither to go. What, but the Great Creator's Inſtinct ſhould ever move a poor fooliſh Bird, to venture over vaſt Tracts of Land, but eſpecially over large Seas? If it ſhould be ſaid, That by their high Aſcents up into the Air, they can ſee croſs the Seas; yet what ſhould teach or perſwade them, that that Land is more proper for their Purpoſe, than this? That *Britain*, (for Inſtance,) ſhould afford them better Accommodations than *Ægypt* (*d*), than the *Canaries*, than *Spain*, or

(*c*) *Quis non cum admiratione videat ordinem & politiam peregrinantium Avium, in itinere, turmatim volantium, per longos terrarum & maris tractus abſque Acu marinâ?——Quis eas certum iter in aëris mutabili regione docuit? Quis præteritæ ſigna, & futuræ viæ indicia? Quis eas ducit, nutrit, & vitæ neceſſaria miniſtrat? Quis inſulas & hoſpitia illa, in quibus victum reperiant, indicavit; modumque ejuſmodi loca in peregrinationibus ſuis inveniendi? Hæc ſanè ſuperant hominum captum & induſtriam, qui non niſi longis experientiis, multis itinerariis, chartis geographicis,——& acûs magneticæ beneficio,—— ejuſmodi marium & terrarum tractus conficere tentant & audent.* Lud. de Beaufort. Coſmop. divina Sect. 5. Cap. 1.

(*d*) I inſtance particularly in *Ægypt*, becauſe Mr. *Willughby* thinks *Swallows* fly thither, and into *Æthiopia*, &c. and that they do not lurk in Holes, or under Water, as *Olaus Magnus* reports. *Vide Ornith.* lib. 2. cap. 3. But *Etmuller* puts the Matter out of Doubt; who ſaith, *Memini me plures, quàm quas Medimnus caperit, Hirundines arctè coacervatas intra Piſcinæ cannas, ſub glacie prorſus ad ſenſum exanimes pulſantes tamen, reperriſſe.* Etmuller Differt. 2. cap. 10. ſect. 5. This, as it is like what *Ol. Magnus* ſaith, ſo is a Confirmation of it. The Archbiſhop's

or any of those many intermediate Places over which some of them probably fly.

And lastly, to all this, let us briefly add the Accommodations these *Birds of Passage have*, to enable them to take such long Flights, *viz.* the Length of their Wings, or their more than ordinary Strength (*e*) for Flight.

Account is, *In Septentrionalibus aquis sæpius casu Piscatoris exhauriuntur Hirundines, in modum conglomeratæ massæ, quæ ore ad os, & alâ ad alam, & pede ad pedem post principium autumni sese inter cannas descensuræ colligârunt. ——Massa autem illa per imperitos adolescentes ——extracta, atque in æstuaria portata, caloris accessu Hirundines resolutæ, volare quidem incipiunt, sed exiguo tempore durant.* Ol. Mag. Hist. l. 19. c. 20.

Since my penning this Note, we had, at a Meeting of the Royal-Society, *Feb.* 12, 171$\frac{2}{3}$. a farther Confirmation of *Swallows* retiring under Water in Winter, from Dr. *Colas*, a Person very curious in these Matters; who speaking of their Way of Fishing in the Northern Parts, by breaking Holes, and drawing their Nets under the Ice, saith, That he saw sixteen Swallows so drawn out of the Lake of *Samrodt*, and about Thirty out of the King's great Pond in *Rosineilen*; and that at *Schlebitten*, near an House of the Earl of *Dohna*, he saw two Swallows just come out of the Waters, that could scarce stand, being very wet and weak, with their Wings hanging on the Ground: And that he hath observ'd the Swallows to be often weak for some Days after their Appearance.

(*e*) As *Swallows* are well accommodated for long Flights, by their long Wings, so are *Quails* by the Strength of their *pectoral Muscles*, by the Breadth of their Wings, &c. For Quails have but short Wings for the Weight of their Body; and yet they fly from us into warmer Parts against Winter, and to us in Spring, crossing our Seas. So divers Travellers tell us they cross the *Mediterranean* twice a Year, flying from *Europe* to *Africa*, and back again: Thus *Bellonius*, in Mr. *Willughby*, saith, *When we sail'd from* Rhodes *to* Alexandria *of* Ægypt, *many* Quails *flying from the North towards the South, were taken in our Ship; whence I am verily perswaded, that they shift Places: For formerly also, when I sail'd out of the Isle of* Zant *to* Morea, *or* Negropont, *in the Spring-Time, I had observ'd* Quails *flying the contrary Way, from South to North, that they might abide there all Summer. At which Time also, there were a great many taken in our Ship.* Ornith. p. 170.

CHAP.

CHAP. IV.
Of the Incubation of BIRDS.

ANother Thing relating to the State of this Tribe of Animals, is their *Incubation*.

And firſt, the *Egg* it ſelf deſerves our Notice. Its Parts within, and its cruſty Coat without, are admirably well fitted for the Buſineſs of Incubation. That there ſhould be one Part provided for the Formation of the Body (*a*), before its *Exit* into the World, and another for its Nouriſhment, after it is come into the World, till the Bird is able to ſhift for, and help it ſelf; and that theſe Parts ſhould be ſo accurately brac'd, and kept in due Place (*b*), is certainly a deſign'd, as well as curious Piece of Workmanſhip. And

(*a*) *The Chicken is form'd out of, and nouriſh'd by the White alone, till it be grown Great. The Yolk ſerves for the Chicken's Nouriſhment, after it is well grown, and partly alſo after it is hatch'd. For a good Part of the Yolk remains after Excluſion, being receiv'd into the Chicken's Belly; and being there reſerv'd, as in a Store-houſe, is by the* [Appendicula, *or* Ductus Inteſtinalis,] *as by a Funnel, convey'd into the Guts, and ſerves inſtead of Milk*, &c. Willughby's Ornith. l. 1. c. 3. *Ipſum animal ex albo liquore Ovi corporatur. Cibus ejus in luteo eſt.* Plin. lib. 10. cap. 53.

Ariſtotle ſaith, *The long ſharp Eggs brings Females; the round ones, with a larger Compaſs at the ſharper End, Males.* Hiſt. An. l. 6. c. 2. After which, he tells of a Sott at *Syracuſe*, that ſate Drinking ſo long, till Eggs were hatch'd; as alſo the Cuſtom of *Ægypt*, of hatching Eggs in Dunghills.

(*b*) As the Shell and Skin keep the Yolk and two Whites together; ſo each of the Parts, (the Yolk and Inner White at leaſt,) are ſeparated by Membranes, involving them. At each End of the Egg is a Treddle, ſo call'd, becauſe it was formerly thought to be the Sperm of the Cock. *But the Uſe of theſe*, (ſaith Dr. *Harvey* in *Willugh. Ornith.* c. 3.) *is to be as*

And then as to the Act it ſelf, of *Incubation*, What a prodigious Inſtinct is it in all, or almoſt all the ſeveral Species of Birds, that they, and only they, of all Creatures, ſhould betake themſelves to this very Way of Generation? How ſhould they be aware that their Eggs contain their Young, and that their Production is in their Power (*c*)? What ſhould move them to betake themſelves to their Neſts, and there with Delight and Patience to abide the due Number of Days? And when their Young are gotten into the World, I have already ſhewn how admirable their Art, their Care, and Στοργὴ is in bringing them up until, and only until, they are able to ſhift for themſelves.

And

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twere, the Poles of this Microcoſm, and the Connections of all the Membranes twiſted and knit together, by which the Liquors are not only conſerv'd, each in its Place, but do alſo retain their due Poſition one to another. This, although in a great Meaſure true, yet doth not come up to what I have my ſelf obſerv'd; for I find, that theſe *Chalazæ*, or *Treddles*, ſerve not barely to keep the Liquors in their Place, and Poſition to one another; but alſo to keep one and the ſame Part of the Yolk uppermoſt, let the Egg be turn'd nearly which way it will; which is done by this Mechaniſm: The *Chalazæ* are ſpecifically lighter than the Whites, in which they ſwim; and being brac'd to the Membrane of the Yolk, not exactly in the *Axis* of the Yolk, but ſomewhat out of it, cauſeth one Side of the Yolk to be heavier than the other; ſo that the Yolk being by the *Chalazæ* made buoyant, and kept ſwimming in the midſt of two Whites, is by its own heavy Side kept with the ſame Side always uppermoſt; which uppermoſt Side, I have ſome Reaſon to think, is that on which the *Cicatricula* lies; that being commonly uppermoſt in the Shell, eſpecially in ſome Species of Eggs more, I think, than others.

(*c*) All Birds lay a certain Number of Eggs, or nearly that Number, and then betake themſelves to their Incubation; but if their Eggs be withdrawn, they will lay more. Of which, ſee Mr. *Ray's Wiſ. of God*, p. 137.

(*d*) The

And laſtly, when almoſt the Whole Tribe of Birds do thus, by Incubation, produce their Young, it is a wonderful Deviation, that ſome few Families only, ſhould do it in a more novercal Way (*d*), without any Care or Trouble at all, only by laying their Eggs in the Sand, expoſed to the Heat and Incubation of the Sun. Of this the Holy Scripture it ſelf gives us an Inſtance in the Oſtrich: Of which we have an Hint, *Lam.* iv. 3. *The Daughter of my People is become cruel, like the Oſtriches in the Wilderneſs.* This is more plainly expreſſed in *Job* xxxix. 14, 15, 16, 17. [The Oſtrich] *leaveth her Eggs in the Earth, and warmeth them in the Duſt, and forgetteth that the Foot may cruſh them, or that the wild Beaſt may break them. She is hardened againſt her Young ones, as though they were not hers: Her Labour is in vain, without Fear. Becauſe GOD hath deprived her of Wiſdom, neither hath He imparted unto her Underſtanding.* In which Words I ſhall take Notice of three Things: 1. Of this anomalous Way of Generation. It is not very ſtrange, that no other Incubation but that of the

(*d*) The *Tabon* is a Bird no bigger than a Chicken, but is ſaid to lay an Egg larger than a Gooſe's Egg, and bigger than the Bird it ſelf. Theſe they lay a Yard deep in the Sand, where they are hatch'd by the Warmth of the Sun; after which they creep out, and get to Sea for Proviſions. *Navarett's Account of China in Collect. of Voyages.* Vol. 1. This Account is, in all Probability, borrow'd from *Nieremberg*, or *Hernandez*, (that copy'd from him,) who call this Bird by the Name of *Daie*, and its Eggs *Tapun*, not the Bird it ſelf, as *Navarette* doth. But my Friend Mr. *Ray* ſaith of it, *Hiſtoria iſthæc proculdubio fabuloſa & falſa eſt. Quamvis enim Aves nonnullæ maxima ova pariunt, ut v. g.* Alkæ, Lomwiæ, Anates, Arcticæ, *&c. hujuſmodi*

the Sun, ſhould produce their Young; but it is very odd and wonderful that any one Species ſhould vary from all the reſt of the Tribe. But above all, 2. The ſingular Care of the Creator, in this Caſe, is very remarkable, in ſupplying ſome other Way the Want of the Parent-Animals Care and Στοργὴ (*e*), ſo that the Young ſhould, notwithſtanding, be bred up in thoſe large and barren Deſarts of *Arabia* and *Africa*, and ſuch like Places where thoſe Birds dwell, the moſt unlikely and unfitting (in all Human Opinion) to afford Suſtenance to young helpleſs Creatures; but the fitteſt therefore to give Demonſtrations of the Wiſdom, Care, and eſpecial Providence of the Infinite Creator and Conſervator of the World. 3. The laſt Thing I ſhall Remark is, That the Inſtincts of Irrational Animals, at leaſt of this ſpecify'd in the Text, is attributed to GOD. For the Reaſon the Text gives why the *Oſtrich is hardened againſt her Young Ones, as though they were not hers*, is, *Becauſe GOD hath depriv'd her of Wiſdom, and not imparted Underſtanding to her*; i. e. He hath denied her that Wiſdom,

juſmodi tamen unum duntaxat, non plura, ova ponunt antequam incubent: nec ullam in rerum naturâ avem dari exiſtimo cujus ova albumine careant. Cum Albumen præcipua ovi pars ſit, quodque primum fœtui alimentum ſubminiſtrat. Raii Synop. Av. Meth. p. 155.

(*e*) *The Eggs of the Oſtrich being buried in the Sand, are cheriſhed only by the Heat of the Sun, till the Young be excluded. For the Writers of Natural Hiſtory do generally agree, that the old Birds, after they have laid and covered their Eggs in the Sand, forſake them, and take no more Care of them.* Willugh. Ornith. l. 2. c. 8. ſect. 1.

But there is another *Oſtrich* [of *America*] which *Acaret* tells us of, that takes more Care of her Young, by carrying four of her Eggs, a little before ſhe hatcheth, to four Parts of her Neſt, there to breed Worms for Food for her Young. *Acaret's Diſc. in Philoſ. Tranſ.* No. 89.

(*f*) See

Wiſdom, He hath not imparted that Underſtanding, that Στοργὴ, that natural Inſtinct to provide for, and nurſe up her Young, that moſt other Creatures of the ſame, and other Tribes, are endowed with.

Thus I have diſpatch'd what I intended to inſiſt upon concerning the State of this Set of Animals; of which, as alſo of their admirable Inſtincts, a great deal more might deſerve our eſpecial Obſervation; particularly the admirable Curioſity, Art, and Variety of Nidification (*f*), uſed among the various Species of Birds; the great Sagacity, and many Artifices uſed by them in the Inveſtigation and Capture of their Prey (*g*), the due Proportion of the more and leſs uſeful, the Scarcety of the Voracious and Pernicious, and the Plenty of the Manſuete and Uſeful (*h*). Alſo the Variety of their Motion and Flight might deſerve Conſideration, the Swiftneſs of ſuch whoſe Food is to be ſought in far diſtant Places, and different Seaſons (*i*); the ſlower Motion, and ſhort Flights, of others more Domeſtick; and even the Aukwardneſs of ſome others to Flight, whoſe Food is near at Hand, and to be gotten without any great Occaſion of Flight (*k*). Theſe, and divers other ſuch like Things as theſe, I ſay, I might have ſpoken more largely unto; but I ſhall paſs them

(*f*) See *Book* IV. *Chap.* 13.
(*g*) See *Book* IV. *Chap.* 11, and 14.
(*h*) See *Book* IV. the Beginning of *Chap.* 10.
(*i*) See *Book* IV. *Chap.* 8.
(*k*) The *Colymbi*, or *Douckers*, having their Food near at Hand in the Waters, are remarkably made for Diving therein. Their Heads are ſmall, Bills ſharp-pointed, Wings ſmall, Legs flat and broad, and placed backward, and nearer the Tail than in other Birds; and laſtly, their Feet; ſome are whole footed, ſome cloven footed, but withal fin-toed. *Vide Willugh. Ornith. lib.* 3. *ſect.* 5.

by

by with only a bare Mention, having already taken Notice of them in the Company of other Matters of the like Nature, and manifeſted them to be Acts of excellent Deſign, Wiſdom, and Providence, in the Great Creator.

CHAP. V.
The CONCLUSION.

AND now, if we reflect upon the Whole Matter, we ſhall here find another large Tribe of the Creation, abundantly ſetting forth the Wiſdom and Glory of their Great Creator. We praiſe the Ingenuity and Invention of Man, for the Contrivance of various pneumatick Engines; we think them witty, even for their unſucceſsful Attempts to ſwim in, and ſail through that ſubtle Element the Air; and the curious Mechaniſm of that Artiſt is had in Remembrance, and praiſed to this Day, who made a Dove, or an Eagle (*a*) to fly but a ſhort Space. And is not therefore all imaginable Honour and Praiſe due to that Infinite Artiſt, that hath ſo admirably contrived and made all the noble Variety of Birds; that hath with ſuch incomparable Curioſity and Art, formed their Bodies from Head to Tail, without and within, that not ſo much as any Muſcle, or Bone, no, not even a Feather (*b*) is unartificially made, miſplaced, redundant, or defective, in all the

(*a*) Vide *Book* V. *Chap.* 1. *Note* (*aa*).

(*b*) *Deus non ſolùm Angelum, & Hominem, ſed nec exigui & contemptibilis animantis viſcera, nec Avis pennulam, nec Herbæ floſculum, nec Arboris folium, ſine ſuarum partium convenientiâ dereliquit.* Auguſtin. de Civ. Dei, l. 5. c. 11.

ſeveral

everal Families of this large Tribe? But every Thing is so incomparably performed, so nicely fitted up for Flight, as to surpass even the Imitation of the most ingenious Artificer among mortal rational Beings.

BOOK VIII.

Of INSECTS *and* REPTILES.

CHAP. I.

Of INSECTS in General.

HAVING dispatch'd that Part of the Animal World, which used to be accounted the more perfect, those Animals stiled less perfect or imperfect, will next deserve a Place in our *Survey*, because when strictly enquired into, we shall find them to be so far from deserving to be accounted mean and despicable Parts of the Creation, owing their Original and Production to Putrefactions, *&c.* as some have thought, that we shall find them, I say, noble, and most admirable Works of GOD. For, as the famous Natural Historian, *Pliny* (*a*), prefaceth his *Treatise of Insects*, to prevent the Reproach of condescending (as

(*a*) *In magnis siquidem corporibus, &c.* Plin. Nat. Hist. l. 11. c. 2.

(*b*) *Ubi*

(as might be thought) to so mean a Subject: *In great Bodies*, saith he, *Nature had a large and easy Shop to work upon obsequious Matter; whereas, in these so small, and as it were no Bodies, what Footsteps of Reason, what Power, what great Perfection is there?* Of this having given an Instance or two of the exquisite Senses, and curious Make of some Insects (*b*), he then goes on, *We admire*, saith he, *the turrigerous Shoulders of Elephants, the lofty Necks and Crests of others; but*, saith he, *the Nature of Things is never more compleat than in the least Things.* For which Reason he intreats his Readers (as I do mine) *that because they slighted many of the Things themselves which he took Notice of, they would not therefore disdainfully condemn his Accounts of them, since*, saith he, *in the Contemplation of Nature, nothing ought to seem Superfluous.*

Thus that eminent Naturalist hath made his own, and my Excuse too; the Force and Verity whereof will farther appear, by what I shall say of these Animals which (as despicable as they have

(*b*) *Ubi tot sensus collocavit in Culice? Et sunt alia dictu minora. Sed ubi Visum in eo prætendit: Ubi Gustatum applicavit? Ubi Odoratum inseruit? Ubi verò truculentam illam & portione maximam vocem ingeneravit? Quâ subtilitate Pennas adnexuit? prælongavit Pedum crura? Disposuit jejunam Caveam, uti Alvum? Avidam Sanguinis, & potissimum humani, sitim, accendit? Telum verò perfodiendo tergori quo spiculavit ingenio? Atque ut in capaci, cùm cerni non possit exilitas, ita reciprocâ geminavit arte, ut fodiendo acuminatum pariter forbendoque fistulosum esset. Quos Teredini ad perforanda Robora cum sono teste dentes affixit? Potissimumque è ligno cibatum fecit: Sed turvigeros Elephantorum miramur humeros, Taurorumque colla, & truces in sublime jactus, Tigrium rapinas, Leonum jubas, cùm rerum natura nusquam magis quàm in minimis, tota sit.* Plin. ibid.

been,

been, or perhaps may be thought) we ſhall find as exquiſitely contrived, and curiouſly made for that Place and Station they bear in the World, as any other Part of the Animal World. For if we conſider the innumerable Variety of their Species, the prodigious Numbers of Individuals, the Shape and Make of their little Bodies, and every Part thereof, their Motion, their Inſtincts, their regular Generation and Production; and, to name no more, the incomparable Beauty and Luſtre of the Colours of many of them, what more admirable and more manifeſt Demonſtration of the Infinite Creator, than even this little contemned Branch of the Animal World? But let us take a ſhort View of Particulars.

CHAP. II.

Of the Shape and Structure of Inſects.

LET us begin with the Shape and Fabrick of their Bodies. Which although it be ſomewhat different from that of Birds, being particularly, for the moſt Part, not ſo ſharp before, to cut and make way through the Air, yet is better adapted to their Manner of Life. For conſidering that there is little Neceſſity of long Flights, and that the Strength and Activity of their Wings doth much ſurpaſs the Reſiſtance their Bodies meet with from the Air, there was no great Occaſion their Bodies ſhould be ſo ſharpened before. But the Condition of their Food, and the Manner of gathering it, together with the great Neceſſity of accurate Viſion, by that admirable

ble Proviſion made for them by the reticulated *Cornea* of their Eyes; theſe Things, I ſay, as they required a larger Room, ſo were a good Occaſion for the Largeneſs of the Head, and its Amplitude before. But for the reſt of their Body, all is well made, and nicely poiſed for their Flight, and every other of their Occaſions.

And as their *Shape*, ſo the *Fabrick* and *Make* of their Bodies is no leſs accurate, admirable, and ſingular; not built throughout with Bones, and cover'd with Fleſh and Skin, as in moſt other Animals; but cover'd with a curious Mail of a middle Nature (*a*), ſerving both as Skin and Bone too, for the Shape, as well as Strength and Guard, of the Body; and as it were on Purpoſe to ſhew, That the Great Contriver of Nature is not bound up to one Way only.

(*a*) *Inſecta non videntur Nervos habere, nec Oſſa, nec Spinas, nec Cartilaginem, nec Pinguia, nec Carnes, nec cruſtam quidem fragilem, ut quædam marina, nec quæ jure dicatur Cutis: ſed media cujuſdam inter omnia hæc naturæ corpus, &c.* Plin. Nat. Hiſt. l. 11. c. 4.

CHAP. III.

Of the Eyes and Antennæ of Inſects.

TO this laſt-mention'd Guard, we may add, that farther Guard provided in the *Eyes* and *Antennæ*. The Structure of the Eye, is, in all Creatures, an admirable Piece of Mechaniſm; but that obſervable in the Eyes of Inſects ſo peculiar, that it muſt needs excite our Admiration: Fenced with its own Hardneſs, yea, even its own accurate Viſion,

Viſion, is a good Guard againſt external Injuries; nd its *Cornea*, or outward Coat, all over beſet vith curious, tranſparent, lenticular (*a*) Inlets, enbling thoſe Creatures to ſee, (no doubt,) very acurately every Way, without any Interval of Time r Trouble to move the Eye towards Objects.

And as for the other Part, the *Antennæ*, or *Feelers*, whatever their Uſe may be in cleaning he Eyes, or other ſuch like Uſe; they are, in ll Probability, a good Guard to the Eyes and Head, in their Walk and Flight, enabling them, y the Senſe of Feeling, to diſcover ſuch Annoynces, which by their Proximity may perhaps eſcape

(*a*) The *Corneæ* of Flies, Waſps, &c. are ſo Common an Entertainment with the Microſcope, that every Body knows t is a curious Piece of Lattice-work. In which this is remarkable, that every *Foramen* is of a lenticular Nature; ſo hat we ſee Objects through them topſey-turvey, as through o many convex Glaſſes: Yea, they become a ſmall Teleſcope, when there is a due focal Diſtance between them and the *Lens* of the Microſcope.

This lenticular Power of the *Corneæ*, ſupplies, (as I imagine,) the Place of the Cryſtalline, if not of the vitreous Humour too, there being neither of thoſe Humours that I could ever find, (although for Truth ſake, I confeſs I have not been ſo diligent as I might in this Enquiry;) but inſtead of *Humours* and *Tunicks*, I imagaine that every *Lens* of the *Cornea*, hath a diſtinct Branch of the *Optic Nerve* miniſtring to it, and rendring it as ſo many diſtinct Eyes. So that as moſt Animals are binocular, Spiders for the moſt Part octonocular, and ſome, (as Mr. *Willughby* thought, *Raii Hiſt. Inſect. p.* 12,) ſenocular; ſo Flies, &c. are multocular, having as many Eyes as there are Perforations in their *Corneæ*. By which Means, as other Creatures are oblig'd to turn their Eyes to Objects, theſe have ſome or other of their Eyes ready plac'd towards Objects, nearly all round them: Thus particularly it is in the *Dragon-Fly*, (*Libella*,) the greateſt Part of whoſe Head is poſſeſs'd by its Eyes: Which is of excellent Uſe to that predatious Inſect, for the ready ſeeing and darting at ſmall Flies all round it, on which it preys.

(*b*) It

eſcape the Reach of the Eyes and Sight (*b*). Beſides which, they are a curious Piece of Workmanſhip, and in *May*, a very beautiful Piece of (*c*) Garniture to the Body.

(*b*) It is manifeſt, that Inſects clean their Eyes with their Fore-legs, as well as *Antennæ*. And conſidering, that as they walk along, they are perpetually feeling, and ſearching before them, with their *Feelers*, or *Antennæ*; therefore I am apt to think, that beſides wiping and cleaning the Eyes, the Uſes here nam'd may be admitted. For as their Eyes are immoveable, ſo that no Time is requir'd for the turning their Eyes to Objects; ſo there is no Neceſſity of the *Retina*, or *Optic Nerve* being brought nigher unto, or ſet farther off from the *Cornea*, (which would require Time,) as it is in other Animals: But their *Cornea* and *Optic Nerve*, being always at one and the ſame Diſtance, are fitted only to ſee diſtantial Objects, but not ſuch as are very nigh: Which Inconvenience the *Feelers* obviate, leſt it ſhould be prejudicial, in occaſioning the Inſect to run its Head againſt any Thing.

And that this, rather than the wiping the Eyes, is the chief Uſe of the *Feelers*, is farther manifeſt from the *Antennæ* of the *Fleſh Fly*, and many other Inſects, which are ſhort, and ſtrait, and incapable of being bent unto, or extended over the Eyes: As alſo from others enormouſly long, ſuch as thoſe of the *Capricorni*, or *Goat-chafers*, the *Cadew-Fly*, and divers others, both Beetles and Flies.

(*c*) The lamellated *Antennæ* of ſome, the clavellated of others, the neatly articulated of others, the Feather'd and divers other Forms of others, of the *Scarab*, *Papilionaceous*, *Gnat*, and other Kinds; are ſurprizingly Beautiful, when view'd through a Microſcope. And in ſome, thoſe *Antennæ* diſtinguiſh the Sexes: As in the *Gnat-kind*, all thoſe with Tufts, Feathers, and Bruſh-horns, are Males; thoſe with ſhort, ſingle ſhafted *Antennæ*, are Females.

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CHAP. IV.

Of the Parts and Motions of Inſects.

FROM the Head, paſs we to the Members, concern'd in their Motion. And here we have a copious Subject, if I was minded to expatiate. I might take Notice of the admirable Mechaniſm in thoſe that creep; the curious Oars in thoſe amphibious Inſects that ſwim and walk (*a*); the incomparable Proviſion made in the Feet of ſuch as walk, or hang upon ſmooth Surfaces (*b*); the great Strength and Spring in the Legs of ſuch as

(*a*) All the Families of *Hydrocanthari*, *Notonecti*, &c. have their hindmoſt Legs made very nicely, with commodious Joynts flat, and Briſtles on each Side towards the End, ſerving for Oars to ſwim; and then, nearer the Body, are two ſtiff Spikes, to enable them to walk when Occaſion is.

(*b*) I might here name divers Flies, and other Inſects, who, beſides their ſharp hook'd Nails, have alſo ſkinny Palms to their Feet, to enable them to ſtick on Glaſs, and other ſmooth Bodies, by Means of the Preſſure of the Atmoſphere. But becauſe the Example will illuſtrate another Work of Nature, as well as this, I ſhall chuſe a ſingular Piece of Mechaniſm, in one of the largeſt Sorts of *Hydrocanthari*. Of theſe large ones there are two Sorts, one largeſt, all black, with *Antennæ* handſomely emboſs'd at the Ends. The other ſomewhat leſſer, hardly ſo black, with capillary *Antennæ*; the Forehead, Edges of the *Vaginæ*, and two Rings on the *Thorax*, of a tawny Colour. The Female hath *Vaginæ* prettily furrow'd, the Male ſmooth. But that which is moſt to our Purpoſe in this Male, is a Flap, or hollowiſh Cap near the middle Joynt of the Fore-legs; which when clap'd on the Shoulders of the Female *in Coitu*, ſticks firmly thereon: After the Manner as I have ſeen Boys carry heavy Stones, with only a wet Piece of Leather clap'd on the Top of the Stone.

as leap (*c*); the ſtrong and well-made Feet and Talons of ſuch as dig (*d*): And to name no more, the admirable Faculty of ſuch as cannot fly, to convey themſelves with Speed and Safety, by the Help of their Webs (*e*), or ſome other Artifice to make their Bodies lighter than the Air (*f*): Theſe, and

(*c*) Thus *Graſhoppers* and *Crickets* have brawny ſtrong Thighs, with long, ſlender, but ſtrong Legs, which enable them to leap with great Agility and Strength.

(*d*) I have wonder'd to ſee with what great Quickneſs, Art and Strength, many *Veſpæ-Ichneumons*, *Wild-Bees*, and *Beetles*, perforate the Earth; yea, even Wood it ſelf: But the moſt remarkable Animal in this Way, is the *Mole-Cricket*, in *Book* IV. *Chap.* 13. *Note* (*s*).

(*e*) I have with Pleaſure often ſeen Spiders dart out their Webs, and ſail away by the Help thereof. For the Manner of which, ſee Mr. *Lowth. Abridg. Vol.* 2. *p.* 794. from Dr. *Liſter* and Dr. *Hulſe*, who both claim'd the Diſcovery thereof. And do both ſeem to have hit thereupon, without any Foreknowledge of what each other hath diſcover'd, as is ſaid in the laſt cited Place, and as I more particularly find by Mr. *Ray*'s *Philoſ.* Letters, Printed *Ann.* 1718. *p.* 95, *&c.* By which alſo I find the two ingenious Doctors were very modeſt in their Claims, and very amicable in the Matter. In one of Dr. *Liſter*'s to Mr. *Ray*, he thinks there is a fair Hint of the Darting of Spiders in *Ariſtot. Hiſt. An. l.* 9. *c.* 39. And in *Pliny*, *l.* 11. *c.* 24. But for their Sailing, that the Ancients are ſilent of, and he thinks it was ſeen firſt by him. And in another Letter, *Jan.* 20, 1670. ſpeaking of the Height Spiders are able to fly, he ſaith, *The laſt* October, &c. *I took Notice, that the Air was very full of Webs, I forthwith mounted to the Top of the higheſt Steeple on the Minſter*, [in York,] *and could there diſcern them yet exceeding high above me. Some that fell and were intangled upon the Pinacles, I took, and found them to be* Lupi; *which Kind ſeldom or never enter Houſes, and cannot be ſuppos'd to have taken their Flight from the Steeple.*

(*f*) There are, (I imagine,) divers Animals, as well as Spiders, that have ſome Way of Conveyance, as little known to us, as that of Spiders formerly was. Thus the *Squillulæ pulices Arboreſcentes*, and *microſcopical Animalcules* of the ſtagnating Waters, ſo numerous in them, as to diſcolour ſometimes the Water, and make them look as if they were tinged

and a Multitude of other ſuch like Things as theſe, I might, I ſay, take Notice of, as great Evidences of the Infinite Creator's Wiſdom: But leſt I ſhould be too tedious, I will confine my Obſervations to the Legs and Wings only. And theſe, at firſt View, we find to be incomparably fitted up for their intended Service, not to over-load the Body, nor in the leaſt to retard it; but to give it the moſt proper and convenient Motion. What, for Example, can be better contriv'd, and made for this Service, than the Wings? Diſtended and ſtrengthen'd by the fineſt Bones, and theſe cover'd with the fineſt and lighteſt Membranes, ſome of them adorn'd with

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ged Red, Yellow or Green, or cover'd with a thick green Scum; all which is nothing but Animalcules of that Colour. That theſe Creatures have ſome Way of Conveyance, I conclude; becauſe moſt ſtagnating Waters are ſtock'd with them; new Pits and Ponds, yea, Holes and Gutters on the Tops of Houſes and Steeples. That they are not bred there by æquivocal Generation, every ingenious, conſidering Philoſopher will grant; that they have not Legs for travelling ſo far, is manifeſt from Inſpection? And therefore I am apt to think, that they have ſome Faculty of inflating their Bodies, or darting out Webs, and making their Bodies buoyant, and lighter than Air; or their Bodies, when dry, may be lighter than Air, and ſo they can ſwim from Place to Place; or the Eggs of ſuch as are oviparous, may be light enough to float in the Air. But then the Viviparous, (as my late ingenious Friend, Mr. *Charles King*, ſhew'd me the *Pulices aquat. arboreſ.* are; theſe (I ſay,) can't be this Way accounted for. The Cauſe of theſe latter Suſpicions was, that in the Summer Months, I have ſeen the *Pulices arboreſ.* and the green Scum on the Waters, (nothing but Animalcules, as I ſaid,) lie in a Manner dry on the Surface of the Waters; (at which Time, as I have ſhewn in *Book* IV. *Chap.* 11. *Note* (*n*),) thoſe Animalcules copulate; and perhaps, they may at the ſame Time change their Quarters, and ſeek out new Habitations for their numerous Offſpring, as well as themſelves.

with neat and beautiful Feathers (*g*); and many of them provided with the fineſt Articulations, and Foldings, for the Wings to be withdrawn, and neatly laid up in their *Vaginæ*, and Caſes, and again readily extended for Flight (*h*).

And then for the Poiſing of the Body, and keeping it upright, and ſteady in Flight, it is an admirable Artifice and Proviſion for this Purpoſe; in ſome, by four Wings (*i*); and in ſuch as have but two, by Pointels, and Poiſes plac'd under the Wings, on each ſide the Body. And

(*g*) It is well known to all Perſons any way converſant in microſcopical Obſervations, that theſe elegant Colours of *Moths*, and *Butterflies*, are owing to neat and well-made Feathers, ſet with great Curioſity and Exactneſs in Rows, and good Order.

(*h*) All that have *Elytra*, *Scarabs* (who have whole *Elytra*, or reaching to the *Podex*, or the Ἡμιελυτροπτερα, ſuch as *Earwigs*, and *Staphilini* of all Sorts, do, by a very curious Mechaniſm, extend and withdraw their membranaceous Wings, (wherewith they chiefly fly;) and it is very pretty to ſee them prepare themſelves for Flight, by thruſting out and unfolding their Wings; and again withdraw thoſe Joynts, and neatly fold in the Membranes, to be laid up ſafely in their *Elytra* or Caſes. For which Service the Bones are well plac'd, and the Joynts miniſtring thereunto are accurately contriv'd, for the moſt compendious, and commodious folding up the Wings.

(*i*) For the keeping the Body ſteady and upright in Flight, it generally holds true, (if I miſtake not,) that all bipennated Inſects have *Poiſes* joyn'd to the Body, under the hinder Part of their Wings; but ſuch as have four Wings, or Wings with *Elitra*, none. If one of the Poiſes, or one of the leſſer auxiliary Wings be cut off, the Inſect will fly as if one Side overbalanc'd the other, until it falleth on the Ground; ſo if both be cut off, they will fly aukwardly, and unſteadily, manifeſting the Defect of ſome very neceſſary Part. Theſe *Poiſes* or *Pointells*, are, for the moſt Part, little Balls, ſet at the Top of a ſlender Stalk, which they can move every Way at Pleaſure. In ſome they ſtand alone, in others, (as in the whole *Fleſh-Fly* Tribe,) they have little Covers or Shields, under which

And laſtly, It is an amazing Thing to reflect upon the ſurprizing Minuteneſs, Art, and Curioſity of the (*k*) Joynts, the Muſcles, the Tendons, the Nerves, neceſſary to perform all the Motions of the Legs, the Wings, and every other Part. I have already mention'd this in the larger Animals; but to conſider, that all theſe Things concur in minute Animals, even in the ſmalleſt Mite; yea, the Animalcules, that, (without good Microſcopes,) eſcape our Sight; to conſider, I ſay, that thoſe minuteſt Animals have all the Joynts, Bones, Muſcles, Tendons and Nerves, neceſſary to that brisk and ſwift Motion that many of them have, is ſo ſtupendious a Piece of curious Art (*l*), as plainly mani-

which they lie and move. The Uſe, no doubt, of theſe *Poiſes*, and *ſecondary* leſſer Wings, is to poiſe the Body, and to obviate all the Vacillations thereof in Flight; ſerving to the Inſect, as the long Pole, laden at the Ends with Lead, doth the *Ropedancer*.

(*k*) As all the Parts of Animals are mov'd by the Help of theſe; ſo there is no doubt, but the minuteſt Animals have ſuch like Parts: But the Muſcles and Tendons of ſome of the larger Inſects, and ſome of the leſſer too, may be ſeen with a Microſcope.

(*l*) The minute Curioſities, and inimitable Fineries, obſervable in thoſe leſſer Animals, in which our beſt Microſcopes diſcover no Botch, no rude ill-made Work, (contrary to what is in all artificial Works of Man,) Do they not far more deſerve our Admiration, than thoſe celebrated Pieces of Human Art? Such as the Cup made of a Pepper-Corn, by *Oſwald Nerlinger*, that held 1200 Ivory Cups, all gilt on the Edges, and having each of them a Foot, and yet affording Room for 400 more, in the *Ephem. Germ.* T. 1. *Addend. ad Obſ.* 13. Such alſo was *Phaëton* in a Ring, which *Galen* thus reflects upon, when he ſpeaks of the Art and Wiſdom of the Maker of Animals, particularly ſuch as are ſmall, *Quanto*, ſaith he, *ipſum minus fuerit, tanto majorem admirationem tibi excitabit; quod declarant Opifices cùm in corporibus parvis aliquid inſculpant: cujus generis eſt quòd nuper quidam in Annulo Phaëtonta qua-*

manifeſteth the Power and Wiſdom of the Infinite Contriver of thoſe inimitable Fineries. But having nam'd thoſe minute Animals, Why ſhould I mention only any one Part of their Bodies, when we have, in that little Compaſs, a whole and compleat Body, as exquiſitely form'd, and, (as far as our Scrutiny can poſſibly reach,) as neatly adorn'd, as the largeſt Animal? Let us conſider, that there we have Eyes, a Brain, a Mouth, a Stomach, Entrails, and every other Part of an Animal Body, as well as Legs and Feet; and that all thoſe Parts have each of them their neceſſary *Apparatus* of Nerves, or various Muſcles, and every other Part that other Inſects have; and that all is cover'd and guarded with a well-made Tegument, beſet with Briſtles, adorn'd with neat Imbrications, and many other Fineries. And laſtly, Let us conſider in how little Compaſs all Art and Curioſity may lie, even in a Body many Times leſs than a ſmall Grain of Sand (*m*); ſo that the leaſt Drop of Water can contain

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tuor equis invectum ſculpſit. Omnes enim equi frænum, os, & dentes anteriores habebant, &c. And then having taken Notice, that the Legs were no bigger than thoſe of a *Gnat*, he ſhews that their Make did not come up to thoſe of the *Gnat*; as alſo, ſaith he, *Major adhuc alia quædam eſſe videtur artis ejus, qui pulicem condidit, Vis atque Sapientia, quod, &c. Cùm igitur Ars tanta in tam abjectis animalibus appareat,——quantam ejus Vim ac Sapientiam in præſtantioribus ineſſe putabimus?* Galen. de Uſ. Part. l. 17. c. 1. fin.

(*m*) It will in ſome Meaſure appear, how wonderfully minute ſome microſcopical Animalcules are, by what follows in the next Note. But becauſe more particular Examples would be endleſs, I ſhall refer to the Obſervations of Mr. *Leuwenhoeck*, and others, in the *Philoſ. Tranſ.* and elſewhere.

(*n*) It

contain many of them, and afford them alſo ſufficient Room to dance and friſk about in (*n*).

Having ſurvey'd as many of the Parts of Inſects as I care to take Notice of; I ſhall in the next Place ſay ſomewhat of their State, and Circumſtances of Life. And here I ſhall take Notice only of two Things, which have been only hinted at before; but will deſerve more particular Conſideration here, as being Acts of a wonderful Inſtinct; namely, Their Security of themſelves againſt Winter; and their ſpecial Care of preſerving their Species.

(*n*) It is almoſt impoſſible, by Reaſon of their perpetual Motion, and changing Places, to count the Number of the Animalcules, in only a Drop of the green Scum upon Water; but I gueſs I have ſometimes ſeen not fewer than 100 friſking about in a Drop no bigger than a Pin's Head. But in ſuch a Drop of Pepper-water, a far greater Number; theſe being much leſs than thoſe.

CHAP. V.

The Sagacity of Inſects to ſecure themſelves againſt Winter.

IT is an extraordinary Act of Inſtinct and Sagacity, obſervable in the Generality of the Inſect-Tribe, that they all take Care to ſecure themſelves, and provide againſt the Neceſſities of Winter. That when the Diſtreſſes of Cold and Wet force them, they ſhould retire to warm and dry Places of Safety, is not ſtrange; but it is a prodigious Act of the Infinite Conſervator's Care, to enable ſome to live in a different Kind of Inſect-State; others to

live, as without Action, so without Food; and others that act and eat, to lay up in Summer sufficient Provisions against the approaching Winter. Some, I say, live in a different State; for having sufficiently fed, nourished, and bred up themselves to the Perfection of their *Vermicular*, *Nympha-State*, in the Summer-Months, they then retire to Places of Safety, and there throw off their *Nympha*, and put on their *Aurelia* or *Chrysalis-State* for all the Winter, in which there are no Occasions for Food. This is the constant Method of many Families of the Insect-Tribe (*a*).

But there are others, and some of them in their most perfect State too, that are able to subsist in a kind of Torpitude, or Sleeping State, without any Food at all; by Reason as there is no Action, so no Waste of Body, no Expence of Spirits, and therefore no need of Food (*b*). But

(*a*) It would be endless to enter into Particulars here, because all the *Papilionaceous*, *Flesh*, and *Ichneumon-Fly* Tribes, and all others that undergo the *Nympha* and *Aurelia*-State, between that of the Egg and *Mature*-State, (which are very numerous) appertain to this *Note*. For a Sample therefore only, I shall take what some may think a mean one, but if considered, deserves our Admiration, and that is the Sagacity of the *White Butter-fly Caterpillar*, which having fed itself its due Time, then retires to Places of Security. I have seen great Trains of them creeping up the Walls and Posts of the next Houses, where, with the Help of some Cobweb-like Filaments, they hang themselves to the Cielings, and other commodious Places, and then become *Aureliæ*; in which State and Places they hang secure from Wet and Cold, till the Spring, and warmer Months, when they are transmuted into Butter-flies.

(*b*) I shall not name any of the particular Species of Insects which live in this State, because they are very numerous, but only remark two Things observable in their Sagacity in this Matter: 1. That they are not driven by Stress of Weather to their Retirement, but seem as naturally to betake

But for others that move and act, and need Food, it is a prodigious Inſtinct and Foreſight the Creator hath imprinted on them, to lay up ſufficient Food in Summer for the Winters (*c*) Neceſſities and Occaſions. And it is very pretty to ſee with what unwearied Diligence all Hands are at work for that Purpoſe, all the warmer Months. Of this the Holy Scripture it ſelf gives us an Inſtance in the *Ant*, calling that little Animal *exceeding wiſe*. Prov. xxx. 24. And the Reaſon is, *ver.* 25. *The Ants are a People not ſtrong, yet they*

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take themſelves thereto, as other Animals do to Reſt and Sleep. For before the Approach of cold Weather, towards the End of Summer, we may ſee ſome Kinds of them flocking together, in great Numbers, within Doors (as *Swallows* do a little before they leave us) as if they were making ready for their Winter's Reſt. 2. That every Species betakes it ſelf to a proper convenient Receptacle; ſome under the Waters to the Bottoms of Ponds; ſome under the Earth, below the Froſts; ſome under Timber, Stone, &c. lying on the Ground; ſome into hollow Trees, or under the Bark, or in the Wood; ſome into warm and dry Places; and ſome into dry alone.

(*c*) There are not many Kinds that thus provide their Food before-hand. The moſt remarkable, are the *Ant* and the *Bee*; concerning the firſt of which, *Origen* hath this Remark, *viz*: *De ſolertiâ Formicarum, venturæ hyemi maturè proſpicientium, ſibique invicem ſub onere feſſis ſuccurrentium; quòdque fruges arroſas condunt, ne rurſus enaſcantur, ſed per annum alimento ſint, non ratiocinationem Formicarum in causâ debemus credere, ſed almam matrem Naturam bruta quoque ſic ornantem, ut etiam minimis addat ſua quædam ingenia.* Orig. cont. Celſ. L. 4.

But as for *Waſps*, *Hornets*, *Humble-bees*, and other *Wild-bees*, *Veſpæ Ichneumons*, and divers others that carry in Materials for Neſts and Food; this is only for the Service of their Generation, for hatching their Eggs, and nouriſhing their Young, not for Supplies in Winter; for they all forſake their Neſts towards Winter, and retire to other Quarters, living (I conceive) without Food all that Time.

(*d*) *Hos*

they prepare their Meat in the Summer. And therefore *Solomon* sends the Sluggard to this little contemptible Creature, to learn Wisdom, Foresight, Care and Diligence. *Prov.* vi. 6, 7, 8. *Go to the Ant, thou Sluggard, consider her Ways, and be wise: which having no Guide, Overseer, or Ruler, provideth her Meat in the Summer, and gathereth her Food in the Harvest.*

To this Scriptural Example, give me leave to anticipate, and subjoin an Observation of the farther great Wisdom of this little Creature; and that is their unparallelled Στοργὴ, their Tenderness, Sagacity, and Diligence about their Young (*d*). 'Tis very diverting, as well as admirable to see, with

(*d*) *Hos vermiculos* [Formicarum Ova vulgò vocatos] *incredibili* στοργῇ *& curâ Formicæ educant, summamque dant operam, ne vel tantillum, quod spectet eorum vermiculorum educationem atque nutritionem, omittant: quem in finem fere semper eosdem ore circumportant secum, ne ulla eos lædet injuria. In museo meo nonnullas istius generis formicas, vitro terrâ repleto, conclusas cum Vermiculis istis adservabam: ibi non sine jucunditate spectabam, quo terra fieret in superficie siccior, eo profundiùs Formicas cum fœtibus suis prorepere: cùm verò aquam adfunderem, visu mirificum erat, quanto affectu, quantâ solicitudine, quantâ* Στοργῇ *omnem in eo collocarent operam, ut fœtus suos siccìore & tuto loco reponerent. Sæpiùs vidi, cùm aliquot diebus aquâ caruissent, atque cùm affuso tantillo aquæ terram illam humectarem, è vestigio à Formicis fœtus suos eo loci fuisse allatos, quos ibi distinctè conspiciebam moveri atque sugere humorem. Multoties sui conatus, ut eos Vermiculos ipse educarem, at semper conatum fefellit eventus: neque ipsas Formicarum Nymphas alimenti jam non indigas unquam sine ipsis Formicis potui fotu artificiali excludere.* J. Swammerd. Epilog. ad Hist. Insect. pag. 153.

Sir *Edward King*, who was very curious in examining the Generation of *Ants*, observes their great Care and Diligence, 1. About their Sperm, or true Eggs, which is a fine white Substance, like Sugar, which they diligently gather together into a Heap, when scattered; and on which they lie in Multitudes, (I suppose, by way of Incubation.) 2. I have observed

with what Affection and Care they carry about their Young in their Mouths, how they expoſe themſelves to the greateſt Dangers, rather than leave their Young expoſed or forſaken; how they remove them from Place to Place in their little Hills, ſometimes to this Part, ſometimes to that, for the Benefit of convenient Warmth, and proper Moiſture; and then again withdraw, and guard them againſt Rain and Cold. Now that this great Wiſdom which the Scriptures attribute unto, and is diſcernible in this little Animal, is owing only to the Inſtinct, or Infuſions of the Great Conſervator of the World, is evident, becauſe either this Wiſdom, Thought, and Forecaſt, is an Act of the Animal it ſelf, or of ſome other Being that hath Wiſdom. But the Animal being Irrational, 'tis impoſſible it can be its own Act, but muſt be derived, or received from ſome Wiſe Being. And who? What can that be, but the Infinite Lord, Conſervator and Governor of all the World?

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ed, ſaith he, in Summer, that in the Morning they bring up thoſe of their Young (call'd Ant-Eggs) towards the Top of the Bank: So that you may from 10 in the Morning, until 5 or 6 in the Afternoon, find them near the Top——for the moſt Part on the South-ſide the Bank. But towards 7 or 8 at Night, if it be cool, or likely to rain, you may dig a Foot deep before you can find them. *Philoſ. Tranſ.* No. 23. or Mr. *Lowthorp's Abridg.* V. 2. p. 7, and 9.

CHAP. VI.

Of the Care of Inſects about their Young.

THE other notable Inſtinct I am to treat of, is the peculiar Art and Care of the Inſect-Tribe, about

about the Preservation of their Species. Here I might speak of many Things, but I have occasionally mentioned divers of them before, under some or other of the General Heads, and therefore shall fix only upon two Things relating to their Special Art and Care about the Production (*a*) of their Young, which have not been so particularly spoken to as they deserve.

One Thing is their singular Providence for their Young, in making or finding out such proper Receptacles and Places for their Eggs and Seed, as that they may receive the Advantage of a sufficient Incubation, and that the Young, when produced, may have the Benefit of proper and sufficient Food, for their Nurture and Education, till they are able to shift for themselves. It is admirable to see with what Diligence and Care the several Species of Insects lay up their Eggs, or Sperm, in their several proper Places; not all in the Waters, in Wood, or on Vegetables; but those whose Subsistence is in the Waters (*b*), in the Water; those

(*a*) The Doctrine of Æquivocal Generation, is at this Day so sufficiently exploded by all learned Philosophers, that I shall not enter the Dispute, but take it for granted, that all Animals spring from other Parent-Animals. If the Reader hath any Doubt about it. I refer him to *Seigneur Redi de Gen. Insect.* and Mr. *Ray's Wisdom of God*, &c. *p.* 344. See also before, *Book* IV. *Chap.* 15. *Note* (*a*).

(*b*) It would be Endless to specifie the various Species of Insects, that have their Generation in the Waters. And therefore I shall only observe of them, 1. That their Eggs are always laid up with great Care, and in good Order. And also, 2. Where proper and sufficient Food is. 3. That in their *Nympha*-State in the Waters, they have Parts proper for Food and Motion; and in many, or most of them, very different from what they have in their *Mature-State*, a manifest

thoſe to whom Fleſh is a proper Food, in Fleſh (*c*); thoſe

ifeſt Argument of the Creator's Wiſdom and Providence. For an Inſtance, ſee *Note* (*r*).

(*c*) As *Seigneur Redi* was one of the firſt that made it his Buſineſs to diſcard Anomalous Generation, ſo he tried more Experiments relating to the Vermination of Serpents, Fleſh, Fiſh, putrified Vegetables; and in ſhort, whatever was commonly known to be the Nurſery of Maggots, more, I ſay, probably, than any one hath done ſince. And in all his Obſervations, he conſtantly found the Maggots to turn to *Aureliæ*, and theſe into *Flies*. But then, ſaith he, *Dubitare cœpi, utrùm omne hoc vermium in carne genus, ex ſolo Muſcarum ſemine, an ex ipſis putrefactis carnibus oriretur, tantoque magis confirmabar in hoc meo dubio, quanto in omnibus generationibut——ſæpiùs videram, in carnibus, antequam verminare inciperent, reſediſſe ejuſdem ſpeciei Muſcas, cujus propago poſtea naſcebatur.* Upon this he tells us, he put Fiſh, Fleſh, &c. into Pots, which he covered cloſe from the Flies with Paper, and afterwards (for the free Air-ſake) with Lawn, whilſt other Pots were left open, with ſuch like Fleſh, &c. in them; that the Flies were very eager to get into the covered Pots; and that they produced not one Maggot, when the open ones had many. *Fr. Redi de Gener. Inſect.*

Among the Inſects that come from the Maggots he mentions, he names *Culices*. Now from the moſt critical Obſervations I have made, I never obſerved any Sort of *Gnat* to come from putrified Fleſh, Vegetables, or any other Thing he taxeth them with. So that either he means by *Culex*, ſome Fly that we call not by the Name of *Gnat*; or elſe their *Gnats* in *Italy*, vary in their Generation from ours in *England*. For among above thirty, near forty, diſtinct Species of *Gnats* that I have obſerved about the Place where I live, I never found any to lay their Eggs in Fleſh, Fiſh, &c. but the largeſt Sort, called by *Aldrovand*, *Culices maximi*; by *Swammerdam*, *Tipulæ terreſtres*, lay their Eggs in Meadows, &c. under the Graſs; one of the larger middle Sort, in dead Beer, Yeaſt, &c. lying on the Tops, or in the Leaks of Beer-Barrels, &c. and all the reſt (as far as ever I have obſerved) lay and hatch in the Waters, as in *Note* (*r*).

The Generation of the Second of theſe being akin to ſome of the foregoing Inſtances, and a little out of the Way, may deſerve a Place here. This *Gnat* lays its Eggs commonly in dead Beer, &c. as I ſaid, and probably in Vinegar, and other ſuch Liquors. Some Time after which, the Maggots are ſo

nume-

thoſe to whom the Fruits (*d*) or Leaves of Vegetables

numerous, that the whole Liquor ſtirreth as if it was alive; being full of Maggots, ſome larger, ſome ſmaller; the larger are the Off-ſpring of our *Gnat*, the ſmaller, of a ſmall dark-coloured Fly, tending to reddiſh; frequent in Cellars, and ſuch obſcure Places. All theſe *Maggots* turn to *Aurelia*, the larger of which, of a Tan-Colour, turn to our *Gnat*. This *Gnat* is of the unarmed Kind, having no Spear in its Mouth. Its Head is larger than of the common *Gnats*, a longer Neck, ſhort-jointed *Antennæ*, ſpotted Wings, reaching beyond its ſlender *Alvus*; it is throughout of a brown Colour, tending to red, eſpecially in the Female: The chief Difference between the Male and Female, is (as in other *Gnats*, yea, moſt Inſects) the Male is leſs than the Female, and hath a ſlenderer Belly, and its *Podex* not ſo ſharp as the Female's is.

(*d*) The Inſects that infeſt Fruits, are either of the *Ichneumon-Fly* Kind, or *Phalænæ*. Plumbs, Peaſe, Nuts, &c. produce ſome or other *Ichneumon-Fly*. That generated in the *Plumb* is black, of a middle Size, its Body near three tenths of an Inch long, its Tail not much leſs, conſiſting of three Briſtles, wherewith it conveys its Eggs into Fruits: Its *Antennæ*, or Horns, long, ſlender, recurved; its Belly longiſh, tapering, ſmall towards the *Thorax*; *Legs* reddiſh; *Wings* membranaceous, thin and tranſparent, in *Number* 4, which is one Characteriſtick of the *Ichneumon-Fly*.

The *Peaſe Ichneumon-Fly*, is very ſmall, Wings large, reaching beyond the *Podex*; *Antennæ* long; *Alvus* ſhort, ſhaped like an Heart, with the Point towards the *Anus*; it walketh and flieth ſlowly. No Tail appears as in the former; but they have one lieth hidden under the Belly, which they can at Pleaſure bend back to pierce Peaſe when they are young and tender, and other Things alſo, as I have Reaſon to ſuſpect, having met with this (as indeed the former two) in divers Vegetables.

Pears and *Apples* I could never diſcover any Thing to breed in, but only the leſſer *Phalæna*, about four-tenths of an Inch long, whitiſh underneath; greyiſh-brown above (dappled with brown Spots, inclining to a dirty Red) all but about a third Part at the End of the Wings, which is not grey, but brown, elegantly ſtriped with wavey Lines, of a Gold Colour, as if gilt; its Head is ſmall, with a Tuft of whitiſh-brown in the Forehead; *Antennæ* ſmooth, moderately long. The *Aurelia* of this Moth is ſmall, of a yellowiſh Brown. I know not what Time they require for their Generation out of Boxes; but

ables are Food, are accordingly repoſited, ſome in his Fruit, ſome on this Tree (*e*), ſome on that Plant (*f*), ſome on another, and another; but conſtantly the ſame Family on the ſame Tree or Plant, the moſt agreeable to that Family. And as for others that require a conſtant and greater Degree of Warmth, they are accordingly provided by the Parent Animal with ſome Place in or about the Body of other Animals; ſome in the Feathers of Birds (*g*); ſome in the Hair of Beaſts

ut thoſe I laid up in *Auguſt*, did not become Moths before *June* following.

(*e*) There are many of the *Phalænæ*, and *Ichneumon-Fly* Tribes, that have their Generation on the Leaves, or other Parts of Trees and Shrubs, too many to be here reckoned up. The *Oak* hath many very beautiful *Phalænæ*, bred in its convolved Leaves, white, green, yellow, brown ſpotted prettily, and neatly dappled, and many more beſides; and its Buds afford a Place for Caſes, and Balls of various Sorts, as ſhall be ſhewn hereafter; its Leaves expanded, miniſter to the Germination of globular, and other ſphæroidal Balls, and flat *Theca*, ſome like Hats, ſome like Buttons excavated in the Middle; and divers others ſuch like Repoſitories, all belonging to the *Ichneumon-Fly* Kind. And not only the *Oak*, but the *Maple* alſo, the *White-Thorn*, the *Briar*, *Privet*, and indeed almoſt every Tree and Shrub.

(*f*) And as Trees and Shrubs, ſo Plants have their peculiar Inſects. The *White-Butterfly* lays its voracious Off-ſpring on Cabbage-Leaves; a very beautiful reddiſh ocellated one, its no leſs voracious black Off-ſpring of an horrid Aſpect, on the Leaves of Nettles; as alſo doth a very beautiful, ſmall, greeniſh *Ichneumon-Fly*, in Caſes on the Leaves of the ſame Plant: And to name no more (becauſe it would be endleſs) the beautiful *Ragwort-Moth*, whoſe upper Wings are brown, elegantly ſpotted with red, and under Wings edged with brown; theſe, I ſay, provide for their golden ring'd *Erucæ* upon the *Ragwort-Plant*.

(*g*) Many, if not moſt Sorts of Birds, are infeſted with a diſtinct Kind of *Lice*, very different from one another in Shape, Size, &c. For Figures and Deſcriptions of them, I ſhall

Beaſts (*h*); ſome in the very Scales of Fiſhes (*i*); ſome in the Noſe (*k*); ſome in the Fleſh (*l*); yea

ſhall refer to *Signieur Redi of Inſects.* See alſo *Mouſet*, *l.* 2. c. 23. Theſe Lice lay their Nits among the Feathers of the reſpective Birds, where they are hatched and nouriſhed; and as *Ariſtotle* ſaith, would deſtroy the Birds, particularly *Pheaſants*, if they did not duſt their Feathers. *Loco infr. citat.*

(*h*) And as Birds, ſo the ſeveral Sorts of Beaſts have their peculiar Sorts of Lice; all diſtinct from the two Sorts infeſting Man: Only the *Aſs*, they ſay, is free, becauſe our Saviour rode upon one, as ſome think; but I preſume it is rather from the Paſſage in *Pliny*, *l.* 11. *c.* 33. or rather *Ariſt. Hiſt. Animal. l.* 3. *c.* 31. who ſaith, *Quibus pilus eſt, non carent eidem* [Pediculo] *excepto Aſino, qui non Pediculo tantùm, verùm etiam Reduvio immunis eſt.* And a little before, ſpeaking of thoſe in Men, he ſhews what Conſtitutions are moſt ſubject to them, and inſtanceth in *Alcman* the Poet, and *Pherecydes Syrius* that died of the *Pthiriaſis*, or Lowſy Diſeaſe. For which foul Diſtemper, if Medicines are deſired, *Mouſet de Inſect. p.* 262. may be conſulted. Who in the ſame Page hath this Obſervation, *Animadverterunt noſtrates——ubi Aſores inſulas à tergo reliquerint, Pediculos confeſtim omnes tabeſcere: atque ubi eas reviſerint, iterum innumeros alios ſubitò oriri.* Which Obſervation is confirmed by Dr. *Stubs. Vid. Lowth. Abridg. V.* 3. *p.* 558. And many Seamen have told me the ſame.

(*i*) Fiſhes, one would think, ſhould be free from Lice, by reaſon they live in the Waters, and are perpetually moving in, and bruſhing through them; but yet they have their Sorts too.

Beſides which, I have frequently found great Numbers of long ſlender Worms in the Stomachs, and other Parts of Fiſh, particularly *Codfiſh*, eſpecially ſuch as are poor; which Worms have work'd themſelves deeply into the Coats and Fleſh, ſo that they could not eaſily be gotten out: So *Ariſtotle* ſaith of ſome Fiſhes, *Ballero & Tilloni Lumbricus innaſcitur, qui debilitat, &c. Chalcis vitio infeſtatur diro, ut Pediculi ſub Branchiis innati quàm multi interimant.* Hiſt. An. L. 8. c. 20.

(*k*) Of Inſects bred in the Noſe of Animals, thoſe in the Noſtrils of *Sheep* are remarkable. I have my ſelf taken out not fewer at a Time than twenty or thirty rough Maggots, lying among the *Laminæ* of the Noſtrils. But I could never hatch any of them, and ſo know not what Animal they proceed from: But I have no great doubt, they are of the *Ichneumon*-

(*l*); yea, ſome in the very Bowels (*m*); and in-
moſt

eumon-Fly Kind; and not improbably of that with a long Tail, call'd *Triſeta*, whoſe three Briſtles ſeem very commodious for conveying its Eggs into deep Places.

I have alſo ſeen a rough whitiſh Maggot, above two Inches within the *Inteſtinum rectum* of Horſes, firmly adhering thereto, that the hard Dung did not rub off. I never could bring them to Perfection, but ſuſpect the *Side-Fly* proceeds from it.

(*l*) In the Backs of *Cows*, in the Summer-Months, there are Maggots generated, which in *Eſſex* we call *Wornils*; which are firſt only a ſmall Knot in the Skin; and I ſuppoſe no other than an Egg laid there by ſome Inſect. By Degrees theſe Knots grow bigger, and contain in them a Maggot lying in a purulent Matter: They grow to be as large as the End of one's Finger, and may be ſqueez'd out at a Hole they have always open: They are round and rough, and of a dirty White. With my utmoſt Endeavour and Vigilance, I could never diſcover the Animal they turn into; but as they are ſomewhat like, ſo may be the ſame as thoſe in the Note before.

In *Perſia* there are very long ſlender Worms, bred in the Legs, and other Parts of Men's Bodies, 6 or 7 Yards long.

In *Philoſ. Tranſ.* Mr. *Dent*, and Mr. *Lewis*, relate divers Examples of *Worms* taken out of the Tongue, Gums, Noſe, and other Parts, by a Woman at *Leiceſter*, which they were Eye-witneſſes of. Theſe, and divers others mention'd in the *Tranſactions*, may be ſeen together in Mr. *Lowthorp*'s *Abridg. Vol.* 3. *p.* 132.

Narrat mihi vir fide dignus——Caſp. Wendlandt——ſe in Poloniâ, puero cuidam ruſtico duorum annorum, Vermiculum album è palpebrâ extraxiſſe,——magnitudinis Erucæ.——Similem ferè huic caſum mihi [Schulzio] *& D. Segero narravit hoc, Anno* 1676. *chirurgus noſter Anat. Statlender, qui cùidam puero, ex Aure, extraxit Vermiculum talem, qualis in nucibus avellanis perforatis latitare ſolet, ſed paulò majorem, coloris albiſſimi; alteri minores 5 ejuſdem generis ſimiliter ex Aure: Omnes aliquot horas ſupervixerunt——Vermiculos adhuc viventes oculis noſtris vidimus.* Ephem. Germ. T. 2. Obſ. 24. ubi Vermiculi Icon. Many other Inſtances may be met with in the ſame Tome. Obſ. 147, 148, 154.

The Worms in *Deer* are mention'd often among Ancient Writers. *Ariſtotle* ſaith, Σκώληκας μέντοι πάντες ἔχουσιν, ἐν τῇ κεφαλῇ ζῶντας, &c. *They* [Deer] *all have live Worms in their Heads; bred under the Tongue, in a Cavity near the* Vertebra, *on*

which the Head is plac'd; their Size not leſs than of the largeſt Maggots; they are bred all together, in number about twenty. Ariſtot. Hiſt. Animal. l. 2. c. 15.

To theſe Examples may be added the Generation of the *Ichneumon-Fly* in the Bodies of Caterpillars, and other *Nymphæ* of Inſects. In many of which, that I have laid up to be hatch'd in Boxes, inſtead of *Papilios*, &c. as I expected, I have found a great Number of ſmall *Ichneumon-Flies*, whoſe Parent-Animal had wounded thoſe *Nymphæ*, and darted in Eggs into them, and ſo made them the Foſter Mother of its Young. More Particulars of this Way of Generation may be ſeen in the great Mr. *Willughby*'s Obſervations in *Philoſ. Tranſ.* No. 76. But concerning the farther Generation of this Inſect, I have taken Notice of other Particulars in other Places of theſe Notes.

(*m*) The Animals ordinarily bred in the Stomach and Guts, are the three Sorts of Worms call'd *Lati Teretes*, and *Aſcarides*; concerning which, it would be irkſome to ſpeak in Particular, and therefore I ſhall refer to *Mouſet*, *l.* 2. *c.* 31, 32, 33. Dr. *Tyſon*'s Anatomy of them in Mr. *Lowthorp*'s *Abridg. V.* 3. *p.* 121. *Seigneur Kedi*'s *Obſ.* and others that have written of them.

And not only *Worms*, but other Creatures alſo are ſaid to be found in the Stomach; Inſtances of which are ſo innumerable, that I ſhall only ſelect a few related by Perſons of the beſt Credit. And firſt of all, by ſome of our own Countrymen. Dr. *Liſter*, (whoſe Credit and Judgment will hardly be queſtion'd,) gives an Account of true *Caterpillars*, vomited up by a Boy of nine Years old; and another odd Animal by a poor Man. Mr. *Jeſſop*, (another very judicious, curious and ingenious Gentleman) ſaw *Hexapods* vomited up by a Girl; which *Hexapods* liv'd and fed for five Weeks. See *Lowth. ib. p.* 135.

And to Foreigners, it is a very ſtrange Story, (but atteſted by Perſons of great Repute,) of *Catharina Geileria*, that dy'd in *Feb.* 1662. in the Hoſpital of *Altenburg*, in *Germany*, who for twenty Years voided by Vomit and Stool, *Toads* and *Lizzards*, &c. *Ephemer. Germ. T.* 1. *Obſ.* 103. See alſo the 109th Obſervation of a Kitten bred in the Stomach, and vomited up; of Whelps alſo, and other Animals, bred in like Manner. But I fear a Stretch of Fancy might help in ſome of thoſe laſt Inſtances, in thoſe Days when ſpontaneous Generation was held, when the Philoſophers ſeem to have more ſlightly examined ſuch Appearances than now they do. But for the breeding of *Frogs* or *Toads*, or *Lacertæ Aquaticæ* in the Stomach, when their Spawn happeneth to be drank, there is

moſt Receſſes of the Bodies of Man and other Creatures (*n*): And as for others to whom none of theſe

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s a Story in the ſecond *Tome* of the *Ephem. Germ. Obſ.* 56. hat favours it, *viz. In the Year* 1667, *a* Butcher's *Man going to uy ſome Lambs in the Spring, being thirſty, drank greedily of ſome landing Water, which a while after, caus'd great Pains in his Stomach, which grew worſe and worſe, and ended in dangerous Symptoms. At aſt he thought ſomewhat was alive in his Stomach, and after that, omited up three live Toads; and ſo recover'd his former Health.*

Such another Story Dr. *Sorbait* tells, and avoucheth it ſeen with his own Eyes, of one that had a Toad came ut of an Abſceſs, which came upon drinking foul Water. *Obſ.* 103.

(*n*) Not only in the Guts, and in the Fleſh; but in many ther Parts of the Body, Worms have been diſcover'd. One was voided by Urine, by Mr. *Mat. Milford*, ſuppos'd to have ome from the Kidneys. *Lowth. ib. p.* 135. More ſuch Examples *Mouſet* tells of. *Ibid.* So the *Vermes Cucurbitini* are very ommon in the Veſſels in Sheeps Livers: And Dr. *Liſter* ells of them, found in the Kidney of a Dog, and thinks that he Snakes and Toads, *&c.* ſaid to be found in Animals Bodies, may be nothing elſe. *Lowth. ib. p.* 120. Nay, more than all this: In Dr. *Bern. Verzaſcha*'s ſixth Obſervation, there are divers Inſtances of Worms bred in the *Brain* of Man. One, a Patient of his, troubled with a violent Headach, and an Itching about the Noſtrils, and frequent Sneezing; who, with the Uſe of a Sneezing-Powder, voided a Worm, with a great deal of Snot from his Noſe. A like Inſtance he gives from *Bartholine*, of a Worm voided from the Noſe of *O. W.* which he gueſſeth was the famous *Olaus Wormius*: Another, from a Country-Woman of *Dietmarſh*; and others in *Tulpius*, *F. Hildanus*, *Schenckius*, &c. Theſe Worms he thinks are undoubtedly bred in the Brain: But what way they can come from thence, I can't tell. Wherefore I rather think, they are ſuch Worms as are mentioned in *Note* (*k*), and even that Worm that was actually found in the Brain of the *Paris* Girl (when opened) I gueſs might be laid in the *Laminæ* of the Noſtrils, by ſome of the *Ichneumon*, or other Inſect-Kind, and might gnaw its way into the Brain, through the *Os cribiforme*. Of this he tells us from *Bartholine*, *Tandem cùm tabida obiiſſet, ſtatim aperto cranio præſentes Medici totam cerebelli ſubſtantiam, quæ ad dexterum vergit, à reliquo corpore ſejunctam, nigrâque tunicâ involutam deprehenderunt: hac tunica rupta, latentem*

these Methods are proper, but make themselves Nests by Perforations in the Earth, in Wood, or Combs they build, or such like Ways; 'tis admirable to see with what Labour and Care they carry in, and seal up Provisions, that serve both for the Production of their Young, as also for their Food and Nurture when produced (*o*).

The other Piece of remarkable Art and Care about the Production of their Young, is their Curiosity and Neatness in repositing their Eggs, and in their Nidification.

As to the first of which, we may observe, that great Curiosity and nice Order is generally observ'd by them in this Matter. You shall always see their Eggs laid carefully and commodiously up (*p*). When upon the Leaves of Vegetables, or other Material on Land, always glu'd thereon with Care, with one certain End lowermost, and with

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Vermem vivum, & pilosum, duobus punctis splendidis loco oculorum prodidit, ejusdem fere molis cum reliquâ Cerebri portione, qui duarum horarum spacio supervixit. B. Verzas. Obs. Medicæ, p. 16.

Hildanus tells us such another Story, *viz. Filius Theod. aust der Roulen, Avunculi mei, diuturno vexabatur dolore capitis.——Deinde febriculâ & sternutatione exortâ, ruptus est Abscessus circa os cribrosum ——& Vermis prorepsit.* By his Figure of it, the Maggot was an Inch long, and full of Bristles. *Fabri Hildan. Cent.* 1. *Obs.*

Galenus Wierus (Physician to the *Princ. Jul. & Cleve*) he saith, told him, that he had, at divers Times, found Worms in the *Gall-bladder* in Persons he had opened at *Dusseldorp. Id. ib. Obs.* 60.

(*o*) See before, *Book* IV. *Chap.* 13. *Note* (*c*).

(*p*) Some Insects lay up their Eggs in Clusters, as in Holes of Flesh, and such Places, where it is necessary they should be crouded together; which, no question, prevents their being too much dried up in dry Places, and promotes their hatching. But,

(*q*) As

with handſome juxta-Poſitions (*q*). Or if in the Waters, in neat and beautiful Rows oftentimes, in that ſpermatick, gelatine Matter, in which they are repoſited, and that Matter carefully ty'd and faſtned in the Water, to prevent its Diſſipation (*r*), or

(*q*) As for ſuch as are not to be cluſtered up, great Order is uſed. I have ſeen upon the Poſts and Sides of Windows, little round Eggs, reſembling ſmall Pearl, which produced ſmall hairy Caterpillars, that were very neatly and orderly laid. And to name no more, the *White Butterfly* lays its neat Eggs on the Cabbage Leaves in good Order, always gluing one certain End of the Egg to the Leaf. I call them neat Eggs, becauſe if we view them in a Microſcope, we ſhall find them very curiouſly furrowed, and handſomely made and adorned.

(*r*) By Reaſon it would be endleſs to ſpecify the various Generation of Inſects in the Water, I ſhall therefore (becauſe it is little obſerved) take *Pliny*'s Inſtance of the *Gnat*, a mean and contemned Animal, but a notable Inſtance of Nature's Work, as he ſaith.

The firſt Thing conſiderable in the Generation of this Inſect is (for the Size of the Animal) its vaſt *Spawn*, being ſome of them above an Inch long, and half a quarter Diameter; made to float in the Waters, and tied to ſome Stick, Stone, or other fix'd Thing in the Waters, by a ſmall Stem, or Stalk. In this gelatine, tranſparent Spawn, the Eggs are neatly laid; in ſome Spawns in a ſingle, in ſome in a double ſpiral Line, running round from end to end, as in *Fig.* 9, and 10; and in ſome tranſverſly, as *Fig.* 8.

When the Eggs are by the Heat of the Sun, and Warmth of the Seaſon hatched into ſmall Maggots, theſe Maggots deſcend to the bottom, and by means of ſome of the gelatine Matter of the Spawn (which they take along with them) they ſtick to Stones, and other Bodies at the bottom, and there make themſelves little Caſes or Cells, which they creep into and out of at Pleaſure, until they are arrived to a more mature *Nympha-State*, and can ſwim about here and there, to ſeek for what Food they have occaſion; at which Time, they are a kind of Red-worms, above half an Inch long, as in *Fig.* 11.

Thus far this mean Inſect is a good Inſtance of the Divine Providence towards it. But if we farther conſider, and com-

or if made to float, ſo carefully ſpread and poiſed, as to ſwim about with all poſſible Artifice.

And as to their other Faculty, that of Nidification, whether it be exerted by boring the Earth or Wood, or building themſelves Cells (*s*), or ſpinning and weaving themſelves Caſes and Webs, it is all a wonderful Faculty of thoſe poor little Animals, whether we conſider their Parts wherewith they work, or their Work it ſelf. Thus thoſe who perforate the Earth, Wood, or ſuch like, they have their Legs, Feet, Mouth, yea, and Whole Body accommodated to that Service; their Mouth exactly formed to gnaw thoſe handſome

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pare the three States it undergoes after it is hatched, we ſhall find yet greater Signals of the Creator's Management, even in theſe meaneſt of Creatures. The three States I mean, are its *Nympha-Vermicular* State, its *Aurelia*, and *Mature* State, all as different as to Shape and Accoutrements, as if the Inſect was three different Animals. In its *Vermicular*-State, it is a Red-Maggot, as I ſaid, and hath a Mouth and other Parts accommodated to Food: In its *Aurelia*-State, it hath no ſuch Parts, becauſe it then ſubſiſts without Food; but in its *Mature*, *Gnat*-State, it hath a curious well made Spear, to wound and ſuck the Blood of other Animals. In its *Vermicular*-State, it hath a long Worm-like Body, and ſomething analogous to Fins or Feathers, ſtanding erect near its Tail, and running parallel with the Body, by means of which reſiſting the Waters, it is enabled to ſwim about by Curvations, or flapping its Body, ſide-ways, this way and that, as in *Fig.* 12.

But in its *Aurelia*-State, it hath a quite different Body, with a *Club-Head* (in which the Head, *Thorax*, and Wings of the *Gnat* are incloſed) a ſlender *Alvus*, and a neat *finny Tail*, ſtanding at right Angles with the Body, quite contraty to what it was before; by which Means, inſtead of eaſy flapping ſide-ways, it ſwims by rapid, briſk Jirks, the quite contrary Way; as is in ſome Meaſure repreſented in *Fig.* 13. But when it becomes a *Gnat*, no finny Tail, no Club-Head, but all is made in the moſt accurate Manner for Flight and Motion in the Air, as before it was for the Waters.

(*s*) See *Book* IV. *Chap.* 13. *Notes* (*n*), (*o*). (*t*) Thus

ſome round Holes, their Feet as well made to ſcratch and bore (*t*), and their Body handſomely turned and fitted to follow. But for ſuch as build or ſpin themſelves Neſts, their Art juſtly bids Defiance to the moſt ingenious Artiſt among Men, ſo much as tolerably to copy the nice Geometrical Combs of ſome (*u*), the Earthen Cells of others, or the Webs, Nets and Caſes (*w*) woven by others. And here that natural Glue (*x*) which their

(*t*) Thus the Mouths and other Parts of the *Ichneumon-Waſps* in *Book* IV. *Chap.* 13. *Note* (*c*). So the Feet of the *Gryllotalpa*, *ibid. Note* (*s*).

(*u*) See the laſt cited Places, *Note* (*o*).

(*w*) Of the textrine Art of the *Spider*, and its Parts ſerving to that Purpoſe, ſee the laſt cited Place, *Note* (*x*).

Beſides theſe, *Caterpillars*, and divers other Inſects, can emit Threds, or Webs for their Uſe. In this their *Nympha-State*, they ſecure themſelves from falling, and let themſelves down from the Boughs of Trees, and other high Places, with one of theſe Threads. And in the Caſes they weave, they ſecure themſelves in their *Aurelia-State*.

And not only the Off-ſpring of the *Phalæna-Tribe*, but there are ſome of the *Ichneumon-Fly* Kind alſo, endowed with this textrine Art. Of theſe I have met with two Sorts; one that ſpun a Milk-white, long, round, ſilken Web, as big as the top of ones Finger, not hollow within, as many are, but filled throughout with Silk. Theſe are woven round Bents, Stalks of Ribwort, &c. in Meadows. The other is a lump of many yellow, ſilken Caſes, ſticking confuſedly together on Poſts, under Cole-worts, &c. Theſe Webs contain in them, ſmall, whitiſh Maggots; which turn to a ſmall, black *Ichneumon-Fly*, with long, capillary *Antennæ*; Tan-coloured Legs; long Wings reaching beyond their Body, with a black Spot near the middle; the *Alvus* like an Heart; and in ſome, a ſmall ſetaceous Tail. Some of theſe Flies were of a ſhining, beautiful green Colour. I could not perceive any Difference, at leaſt, not ſpecifical, between the Flies coming from thoſe two Productions.

(*x*) I have often admired how *Waſps*, *Hornets*, *Ichneumon-Waſps*, and other Inſects that gather dry Materials for building their Neſts, have found a proper Matter to cement and

their Bodies afford ſome of them to conſolidate their Work, and combine its Materials together, and which in others can be darted out at Pleaſure, and ſpun and woven by them into ſilken Balls (*y*) or Webs. I ſay, this ſo peculiar, ſo ſerviceable a Material, together with the curious Structure of all Parts miniſtring to this textrine Power, as mean a Buſineſs as it may ſeem, is ſuch as may juſtly be accounted among the noble Deſigns and Works of the Infinite Creator and Conſervator of the World.

In the laſt Place, there is another prodigious Faculty, Art, Cunning, or what ſhall I call it? that others of thoſe little Animals have, to make even Nature it ſelf ſerviceable to their Purpoſe; and that is the making the Vegetation and Growth of Trees and Plants, the very Means of the building of their little Neſts and Cells (*z*), ſuch as are the

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glue their Combs, and line their Cells; which we find always ſufficiently context and firm. But in all Probability, this uſeful Material is in their own Bodies; as 'tis in the *Tinea veſtivora*, the *Cadew-Worm*, and divers others. *Goedart* obſerves of his *Eruca*, *Num.* xx. 6. that fed upon *Swallow-Leaves*, that it made its Cell of the comminuted Leaves, glued together with its own Spittle, *hæc pulveris aut arenæ inſtar comminuit, ac pituitoſo quodam ſui corporis ſucco ita maceravit, ut inde accommodatum ſubeundæ mutationi inſtanti locum ſibi exſtruxerit. Domuncula hæc à communi Salicum ligno nihil differre videbatur, niſi quòd longè eſſet durior, adeò ut cultro vix diſrumpi poſſet.*

(*y*) *An ingenious Gentlewoman of my Acquaintance, Wife to a learned Phyſician, taking much Pleaſure to keep Silk-Worms, had once the Curioſity to draw out one of the oval Caſes, which the Silk-Worm ſpins——into all the Silken Wire it was made up of, which, to the great Wonder as well of her Husband, as her ſelf,——appeared to be, by meaſure, a great deal above* 300 *Yards, and yet weighed but two Grains and an half.* Boyle Subtil. of Effluv. ch. 2.

(*z*) Since my penning this, I have met with the moſt ſagacious *Malpighi*'s Account of *Galls* &c. and find his Deſcriptions

tions to be exceedingly accurate and true, having traced my ſelf many of the Productions he hath mentioned. But I find *Italy* and *Sicily* (his Book *de Gallis* being publiſhed long after he was made Profeſſor of *Meſſina*) more luxuriant in ſuch Productions than *England*, at leaſt, than the Parts about *Upminſter* (where I live) are. For many, if not moſt of thoſe about us, are taken Notice of by him, and ſeveral others beſides that I never met with; although I have for many Years as critically obſerved all the Excreſcences, and other morbid Tumors of Vegetables, as is almoſt poſſible, and do believe that few of them have eſcaped me.

As to the Method how thoſe *Galls* and *Balls* are produced, the moſt ſimple, and conſequently the moſt eaſy to be accounted for, is that in the Gems of Oak, which may be called *Squamous-Oak-Cones*, *Capitula ſquamata*, in *Malpighi*: Whoſe Deſcription not exactly anſwering our *Engliſh-Cones* in divers Reſpects, I ſhall therefore paſs his by, and ſhew only what I have obſerved my ſelf concerning them.

Theſe *Cones* are, in outward Appearance, perfectly like the Gems, only vaſtly bigger; and indeed they are no other than the Gems, encreaſed in Bigneſs, which naturally ought to be puſhed out in Length: The Cauſe of which Obſtruction of the Vegetation is this: Into the very Heart of the young tender Gem or Bud (which begins to be turgid in *June*, and to ſhoot towards the latter End of that Month, or Beginning of the next; into this, I ſay) the Parent-Inſect thruſts one or more Eggs, and not perhaps without ſome venemous Ichor therewith. This Egg ſoon becomes a Maggot, which eats it ſelf a little Cell in the very Heart or Pith of the Gem, which is the Rudiment of the Branch, together with its Leaves and Fruit, as ſhall be hereafter ſhewn. The Branch being thus wholly deſtroyed, or at leaſt its Vegetation being obſtructed, the Sap that was to nouriſh it, is diverted to the remaining Parts of the Bud, which are only the ſcaly Teguments; which by theſe Means grow large and flouriſhing, and become a Covering to the Inſect-Caſe, as before they were to the tender Branch and its Appendage.

The *Caſe* lying within this Cone, is at firſt but ſmall, as the Maggot included in it is, but by degrees, as the Maggot increaſeth, ſo it grows bigger, to about the Size of a large white Peaſe, long and round, reſembling the Shape of a ſmall Acorn.

The *Inſect* it ſelf, is (according to the modern Inſectologers) of the *Ichneumon-Fly* Kind; with four Membranaceous *Wings*, reaching a little beyond the Body, articulated *Horns*, a large *Thorax*, bigger than the Belly; the Belly ſhort and conical;

the Galls and Balls found on the Leaves and Branches of divers Vegetables, ſuch as the Oak, the Willow (*aa*), the Briar, and ſome others.

Now this is ſo peculiar an Artifice, and ſo far out of the Reach of any mortal Underſtanding, Wit, or Power, that if we conſider the Matter, with ſome of its Circumſtances, we muſt needs perceive manifeſt Deſign, and that there is the Concurrence of ſome Great and Wiſe Being, that hath, from the Beginning, taken Care of, and provided for the Animal's Good: For which Reaſon, as mean as the Inſtance may ſeem, I might be excuſed, if I ſhould enlarge upon its Particulars. But two or three Hints ſhall ſuffice. In

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conical; much like the Heart of Animals; The *Legs* partly whitiſh, partly black. The *Length* of the Body from Head to Tail, about $\frac{1}{10}$ of an Inch; its *Colour*, a very beautiful ſhining Green, in ſome tending to a dark Copper Colour. Figures both of the Cones, Caſes, and Inſects, may be ſeen among *Malpighi*'s Cuts of Galls, *Tab.* 13. and *Tab.* 20. *Fig.* 72. which *Fig.* 72. exhibits well enough ſome others of the *Gall-Inſects*, but its *Thorax* is ſomewhat too ſhort for ours.

(*aa*) Not only the Willow, and ſome other Trees, but Plants alſo, as *Nettles*, *Ground-Ivy*, &c. have Caſes produced on their Leaves, by the Injection of the Eggs of an *Ichneumon-Fly*. I have obſerved thoſe Caſes always to grow in, or adjoining to ſome Rib of the Leaf, and their Production I conceive to be thus, *viz.* The Parent-Inſect, with its ſtiff ſetaceous Tail, terebrates the Rib of the Leaf, when tender, and makes Way for its Egg into the very Pith or Heart thereof, and probably lays in therewith, ſome proper Juice of its Body, to pervert the regular Vegetation of it. From this Wound ariſes a ſmall Excreſcence, which (when the Egg is hatched into a Maggot) grows bigger and bigger, as the Maggot increaſes, ſwelling on each Side the Leaf between the two Membranes, and extending it ſelf into the parenchymous Part thereof, until it is grown as big as two Grains of Wheat. In this Caſe lies a ſmall, white, rough Maggot, which turns to an *Aurelia*, and afterwards to a very beautiful green, ſmall *Ichneumon-Fly*.

(*bb*) What

In the firſt Place, 'tis certain that the Formation of thoſe *Caſes* and *Balls* quite exceeds the Cunning of the Animal it ſelf; but it is the Act partly of the Vegetable, and partly of ſome Virulency (or what ſhall I call it?) in the Juice, or Egg, or both, repoſited on the Vegetable by the Parent-Animal *(bb)*. And as this Virulency is various, according to the Difference of its Animal, ſo is the Form and Texture of the Caſes and Balls excited thereby; ſome being hard Shells *(cc)*, ſome

(bb) What I ſuſpected my ſelf, I find confirmed by *Malpighi*, who in his exact and true Deſcription of the Fly bred in the *Oaken Galls*, ſaith, *Non ſat fuit naturæ tam miro artificio Terebram ſeu Limam condidiſſe; ſed inflicto vulnere, vel excitato foramine infundendum exinde liquorem intra Terebram condidit: quare fractâ per tranſverſam muſcarum terebrâ frequentiſſimè, vivente animali, guttæ aliquot diaphani humoris effluunt.* And a little after, he confirms, by ocular Obſervation, what he imagin'd before, viz. *Semel prope Junii finem vidi Muſcam, qualem ſuperius delineavi, inſidentem quercinæ gemmæ, adhuc germinanti; hærebat etenim foliolo ſtabili ab apice hiantis gemmæ erumpenti; & convulſo in arcum corpore, terebram evaginabat, ipſamque tenſam immittebat; & tumefacto ventre circa terebræ radicem tumorem excitabat, quem interpolatis vicibus remittebat. In folio igitur, avulſâ Muſcâ, minima & diaphana reperi ejecta ova, ſimillima iis, quæ adhuc in tubis ſupererant. Non licuit iterum idem admirari ſpectaculum, &c.*

Somewhat like this, which *Malpighi* ſaw, I had the good Fortune to ſee my ſelf once ſome Years ago: And that was, the beautiful, ſhining *Oak-Ball Ichneumon* ſtrike its *Terebra* into an Oak-Apple divers Times, no doubt to lay its Eggs therein. And hence I apprehend we ſee many *Vermicules* towards the Outſide of many of the Oak-Apples, which I gueſs were not what the Primitive Inſects laid up in the Gem, from which the Oak-Apple had its Riſe, but ſome other ſupervenient, additional Inſects, laid in after the Apple was grown, and whilſt it was tender and ſoft.

(cc) The *Aleppo-Galls*, wherewith we make Ink, may be reckoned of this Number, being hard, and no other than Caſes of Inſects which are bred in them; who when come to Maturity, gnaw their Way out of them; which is the Cauſe

ſome tender Balls (*dd*), ſome Scaly (*ee*), ſome Smooth

Cauſe of thoſe little Holes obſervable in them. Of the Inſects bred in them, ſee *Philoſ. Tranſact.* No. 245. Of this Number alſo are thoſe little ſmooth Caſes, as big as large Pepper-Corns, growing cloſe to the Ribs under Oaken-Leaves, globous, but flattiſh; at firſt touched with a bluſhing red, afterwards growing brown, hollow within, and an hard thin Shell without. In this lieth commonly a rough, white Maggot, which becomes a little long winged, black *Ichneumon-Fly*, that eats a little Hole in the Side of the Gall, and ſo gets out.

(*dd*) For a Sample of the tender Balls, I ſhall chuſe the globous Ball, as round, and ſome as big as ſmall Muſket-Bullets, growing cloſe to the Ribs, under Oaken-Leaves, of a greeniſh yellowiſh Colour, with a bluſh of red; their Skin ſmooth, with frequent Riſings therein. Inwardly they are very ſoft and ſpungy; and in the very Center is a Caſe with a white Maggot therein, which becomes an *Ichneumon-Fly*, not much unlike the laſt. As to this Gall, there is one Thing I have obſerved ſomewhat peculiar, and I may ſay providential, and that is, that the Fly lies all the Winter in thoſe Balls in its Infantile-State, and comes not to its Maturity till the following Spring. In the Autumn, and Winter, theſe Balls fall down with their Leaves to the Ground, and the Inſect incloſed in them is there fenced againſt the Winter Froſts, partly by other Leaves falling pretty thick upon them, and eſpecially by the thick, parenchymous, ſpongy Walls, afforded by the *Galls* themſelves.

Another Sample ſhall be the large *Oak-Balls*, called *Oak-Apples*, growing in the Place of the Buds, whoſe Generation, Vegetation and Figure, may be ſeen in *Malpig. de Gallis, p.* 24. and *Tab.* 10. *Fig.* 33, *&c.* Out of theſe Galls, he ſaith various Species of Flies come, but he names only two, and they are the only two I ever ſaw come out of them: *Frequenter* (ſaith he) *ſubnigræ ſunt muſcæ brevi munitæ terebrâ. Inter has aliquæ obſervantur aureæ, levi viridis tinctura ſuffuſæ, oblongâ pollentes terebrâ.* Theſe two differently coloured Flies, I take to be no other than Male and Female of the ſame Species. I have not obſerved Tails (which are their *Terebræ*) in all, as *Malpighi* ſeems to imitate: Perhaps they were hid in their *Thecæ*, and I could not diſcover them: But I rather think there were none, and that thoſe were the Males: But in others, I have obſerved long, recurvous Tails, longer than their whole Bodies. And theſe I take to be the Females. And

in

Smooth (*ff*), ſome Hairy (*gg*), ſome Long, ſome Round, ſome Conical, *&c.* (*hh*). And in the

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in the *Oak-Apples* themſelves, I have ſeen the *Aureliæ*, ſome with, ſome without Tails. And I muſt confeſs, 'twas not without Admiration as well as Pleaſure, that I have ſeen with what exact Neatneſs and Artifice, the Tail hath been wrapt about the *Aurelia*, whereby it is ſecured from either annoying the Inſect, or being hurt it ſelf.

(*ee*) See before, *Note* (*z*).

(*ff*) As in the preceding Note.

(*gg*) Of the rough or hairy Excreſcences, thoſe on the *Briar*, or *Dog-Roſe*, are a good Inſtance. Theſe *Spongiolæ villoſæ*, as Mr. *Ray*, *Gallæ rumoſæ*, as Dr. *Malpighi* calls them, are thus accounted for by the latter; *Ex copioſis relictis ovis ita turbatur affluens* [Rubi] *ſuccus, ut ſtrumoſa fiant complura tuberculæ ſimul confuſè congeſta, quæ utriculorum ſeriebus, & fibrarum implicatione contexta, ramoſas propagines germinant, ita ut minima quaſi ſylva appareat. Quælibet propago ramos, hinc inde villoſos edit. Hinc inde pili pariter erumpunt, &c.*

Theſe Balls are a ſafe Repoſitory to the Inſect all the Winter in its Vermicular-State. For the Eggs laid up, and hatched the Summer before, do not come to mature Inſects until the Spring following, as Mr. *Ray* rightly obſerves in *Cat. Cantab.*

As to the *Inſects* themſelves, they are manifeſtly *Ichneumon-Flies*, having four Wings, their *Alvus* thick and large towards the Tail; and tapering up till it is ſmall and ſlender at its ſetting on to the *Thorax*. But the *Alvi* or Bellies are not alike in all, though coloured alike. In ſome they are as is now deſcribed, and longer, without *Terebræ*, or Tails; in ſome ſhorter with Tails: And in ſome yet ſhorter, and thick, like the Belly of the *Ant*, or the Heart of Animals, as in thoſe before, *Note* (*z*). But for a farther Deſcription of them, I ſhall refer to Mr. *Ray*, *Cat. Plant. circa Cantab.* under *Roſa ſylveſt.*

(*hh*) It being an Inſtance ſomewhat out of the Way, I ſhall pitch upon it for an Example here, *viz.* The *gouty Swellings* in the Body, and the Branches of the *Blackberry-Buſh*; of which *Malpighi* hath given us two good Cuts in *Tab.* 17. *Fig.* 62. The Cauſe of theſe is manifeſtly from the Eggs of Inſects laid in (whilſt the Shoot is young and tender) as far as the Pith, and in ſome Places not ſo deep: Which for the Reaſons before-mentioned, makes the young Shoots tumify, and grow knotty and gouty. The

the last Place, let us add, That those Species of Insects are all endowed with peculiar and exactly made Parts for this Service, to bore and pierce the Vegetable, and to reach and inject their Eggs and Juice into the tender Parts thereof.

The Insect that comes from hence is of the former Tribe, a small, shining black *Ichneumon-Fly*, about a tenth of an Inch long; with jointed, red, capillary Horns, four long Wings, reaching beyond the Body, a large *Thorax*, red Legs, and a short heart-like Belly. They hop like Fleas. The Males are less than the Females; are very venerous, endeavouring a *Coit* in the very Box in which they are hatch'd; getting up on the Females, and tickling and thumping them with their Breeches and Horns, to excite them to Venery.

The CONCLUSION.

AND now these Things being seriously considered, what less can be concluded, than that there is manifest Design and Forecast in this Case, and that there must needs be some Wise Artist, some Careful, Prudent Conservator, that from the very Beginning of the Existence of this Species of Animals, hath with great Dexterity and Forecast, provided for its Preservation and Good? For what else could contrive and make such a Set of curious Parts, exactly fitted up for that special Purpose: And withal implant in the Body such peculiar Impregnations, as should have such a strange uncouth Power on a quite different Rank of Creatures? And lastly, what should make the Insect aware of this its strange Faculty and Power, and teach it so cunningly and dextrously to employ it for its own Service and Good?

BOOK

BOOK IX.

Of REPTILES, *and the Inhabitants of the WATERS.*

CHAP. I. *Of Reptiles.*

HAVING diſpatch'd the Inſect Tribe, there is but one *Genus* of the Land-Animals remaining to be ſurvey'd; and that is, that of *Reptiles* (*a*). Which I ſhall diſpatch in a little Compaſs, by Reaſon I have ſomewhat amply treated of others, and many of the Things

(*a*) Notwithſtanding I have before, in *Book* IV. *Chap.* 12. *Note* (*p*), taken Notice of the *Earth-Worm*; yet it being a good Example of the Creator's wiſe and curious Workmanſhip, in even this meaneſt Branch of the Creation, I ſhall ſuperadd a few farther Remarks from Drs. *Willis* and *Tyſon*. Saith *Willis*, *Lumbricus terreſtris, licèt vile & contemptibile habetur, Organa vitalia, necnon & alia viſcera, & membra divino artificio admirabiliter fabrefacta ſortitur: totius corporis compages muſculorum annularium catena eſt, quorum fibræ orbiculares contractæ quemque annulum, prius amplum, & dilatum, anguſtiorem & longiorem reddunt.* [This Muſcle

Things may be apply'd here. But there are ſome Things in which this Tribe is ſomewhat ſingular, which I ſhall therefore take Notice of briefly in this Place. One is their Motion, which I have in another Place (*b*) taken Notice of to be not leſs curious, than it is different from that of other Animals, whether we conſider the Manner of it, as vermicular, or ſinuous (*c*), or like that of the Snail

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Muſcle in Earth-Worms I find is ſpiral, as in a good Meaſure is their Motion likewiſe; *ſo that by this Means they can, (like the Worm of an Augre,) the better bore their Paſſage into the Earth. Their Reptile Motion alſo, may be explain'd by a Wire wound on a Cylinder, which when ſlipp'd off, and one End extended and held faſt, will bring the other nearer it. So the Earth-Worm, having ſhot out, or extended its Body, (which is with a wreathing,) it takes hold by thoſe ſmall Feet it hath, and ſo contracts the hinder Part of its Body.* Thus the curious and learned Dr. *Tyſon*, Philoſ. Tranſ. No. 147.] *Nam proinde, cùm portio corporis ſuperior elongata, & exporrecta, ad ſpatium alterius extenditur, ibidemque plano affigitur, ad ipſum quaſi ad centrum portio corporis inferior relaxata, & abbreviata facilè pertrahitur. Pedunculi ſerie quadruplici, per totam longitudinem Lumbrici diſponuntur; his quaſi totidem uncis, partem modo hanc, modo iſtam, plano affigit, dum alteram exporrigit, aut poſt ſe ducit. Supra oris hiatum, Proboſcide, quâ terram perforat & elevat, donatur.* And then he goes on with the other Parts that fall under View, the *Brain*, the *Gullet*, the *Heart*, the *Spermatick Veſſels*, the *Stomachs* and *Inteſtines*, the *Foramina* on the Top of the Back, adjoining to each Ring, ſupplying the Place of Lungs, and other Parts. *Willis de Anim. Brut.* P. 1. c. 3.

(*b*) In *Book* IV. *Chap.* 8.

(*c*) There is a great deal of Geometrical Neatneſs and Nicety, in the ſinuous Motion of Snakes, and other Serpents. For the aſſiſting in which Action, the annular Scales under their Body are very remarkable, lying croſs the Belly, contrary to what thoſe in the Back, and the reſt of the Body do; alſo as the Edges of the foremoſt Scales lie over the Edges of their following Scales, from Head to Tail; ſo thoſe Edges run out a little beyond, or over their following Scales; ſo as that when each Scale is drawn back, or ſet a little upright by its Muſcle, the outer Edge thereof, (or Foot it may be call'd,) is rais'd alſo a little from the Body, to lay hold on the

Snail (*d*), or the Caterpillar (*e*), or the Multipedous (*f*), or any other Way; or the Parts miniſtring

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the Earth, and ſo promote and facilitate the Serpent's Motion. This is what may be eaſily ſeen in the Slough, or Belly of the Serpent-kind. But there is another admirable Piece of Mechaniſm, that my Antipathy to thoſe Animals hath prevented my prying into; and that is, that every Scale hath a diſtinct Muſcle, one End of which is tack'd to the Middle of its Scale; the other, to the upper Edge of its following Scale. This Dr. *Tyſon* found in the *Rattle-Snake*, and I doubt not is in the whole Tribe.

(*d*) The Wiſe Author of Nature, having deny'd Feet and Claws to enable Snails to creep and climb, hath made them amends in a Way more commodious for their State of Life, by the broad Skin along each Side of the Belly, and the undulating Motion obſervable there. By this latter it is they creep; by the former, aſſiſted with the glutinous Slime emitted from the Snail's Body, they adhere firmly and ſecurely to all Kinds of Superficies, partly by the Tenacity of their Slime, and partly by the Preſſure of the Atmoſphere. Concerning this Part, (which he calls the *Snail's Feet*, and their Undulation, ſee Dr. *Liſter's Exercit. Anat.* 1. *ſect.* 1, and 37.

(*e*) The motive Parts, and Motion of Caterpillars, are uſeful, not only to their Progreſſion and Conveyance from Place to Place; but alſo to their more certain, eaſy, and commodious gathering of Food. For having Feet before and behind, they are not only enabled to go by a Kind of Steps made by their fore and hind Parts; but alſo to climb up Vegetables, and to reach from their Boughs and Stalks for Food at a Diſtance; for which Services, their Feet are very nicely made both before and behind. Behind, they have broad Palms for ſticking too, and theſe beſet almoſt round with ſmall ſharp Nails, to hold and graſp what they are upon: Before, their Feet are ſharp and hook'd, to draw Leaves, *&c.* to them, and to hold the fore-part of the Body, whilſt the hinder-parts are brought up thereto. But nothing is more remarkable in theſe Reptiles, than that theſe Parts and Motion are only temporary, and incomparably adapted only to their preſent *Nympha-State*; whereas in their *Aurelia-State*, they have neither Feet nor Motion, only a little in their Hinder-parts: And in their *Mature-State*, they have the Parts and Motion of a flying Inſect, made for Flight.

(*f*) It is a wonderful pretty Mechaniſm, obſervable in the going

ſtring to it, particularly the Spine (*g*), and the Muſcles co-operating with the Spine, in ſuch as have Bone, and the annular, and other Muſcles, in ſuch as have none, all incomparably made for thoſe curious, and I may ſay, geometrical Windings and Turnings, Undulations, and all the various Motions to be met with in the Reptile Kind.

Another Thing that will deſerve our Notice, is, the Poyſon (*h*) that many of this Tribe are ſtock'd with.

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going of *Multipedes*, as the *Juli*, *Scolopendræ*, &c. that on each Side the Body, every Leg hath its Motion, one very regularly following the other from one End of the Body to the other, in a Way not eaſy to be deſcrib'd in Words; ſo that their Legs in going, make a kind of Undulation, and give the Body a ſwifter Progreſſion than one would imagine it ſhould have, where ſo many Feet are to take ſo many ſhort Steps.

(*g*) *Vertebrarum Apophyſes breviores ſunt, præcipue juxta caput, cujus propterea flexus in averſum, & latera, facilis Viperis eſt: ſecus Leonibus, &c.* ——— *Incumbit his Oſſibus ingens Muſculorum minutorum præſidium, tum ſpinas tendinum exilium magno apparatu deducentium, tum vertebras potiſſimum in diverſa flectentium, atque erigentium. Adeoque illam corporis miram agilitatem, non tantùm (ut Ariſtot.)* ὅτι εὐκαμπεῖς καὶ χονδρώδεις ἐι σπόνδυλοι *quoniam faciles ad flexum, & cartilagineas produxit vertebras, ſed quia etiam multiplicia motûs localis inſtrumenta muſculos fabrefecit provida rerum Parens Natura, conſecuta fuit.* Blaſ. Anat. Anim. P. 1. c. 39. de Viperâ è Veſlingio.

That which is moſt remarkable in the Vertebræ [of the *Rattle-Snake*, beſides the other curious Articulations,] *is, that the round Ball in the lower Part of the upper* Vertebra, *enters a Socket of the upper Part of the lower* Vertebra, *like as the Head of the* Os Femoris *doth the* Acetabulum *of the* Os Iſchii; *by which Contrivance, as alſo the Articulation with one another, they have that free Motion of winding their Bodies any way.* Dr. *Tyſon*'s Anat. of the *Rattle-Snake* in *Philoſ. Tranſ.* No. 144. What is here obſerv'd of the *Vertebræ* of this *Snake*, is common to this whole *Genus* of Reptiles.

(*h*) My ingenious and learned Friend, Dr. *Mead*, examined with

with. Which I the rather mention, becauſe ſome make it an Objection againſt the Divine Superintendence and Providence, as being a Thing ſo far from uſeful, (they think,) that 'tis rather miſchievous and deſtructive of God's Creatures. But the Anſwer is eaſy, *viz.* That as to Man, thoſe Creatures are not without their great Uſes, particularly in the Cure of (*i*) ſome of the moſt ſtubborn

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with his Microſcope, the Texture of a *Viper's Poyſon*, and found therein at firſt only *a Parcel of ſmall Salts nimbly floating in the Liquor; but in a ſhort Time the Appearance was chang'd, and theſe ſaline Particles were ſhot out into Cryſtals, of an incredible Tenuity and Sharpneſs, with ſomething like Knots here and there, from which they ſeem'd to proceed; ſo that the whole Texture did in a Manner repreſent a Spider's Web, though infinitely finer.* Mead of Poyſons, p. 9.

As to the Nature and Operation of this *Poyſon*, ſee the ſame ingenious Author's Hypotheſis, in his following Pages.

This *Poyſon* of the *Viper* lieth in a Bag in the Gums, at the Upper-end of the Teeth. It is ſeparated from the Blood by a *conglomerated Gland*, lying in the anterior lateral Part of the *Os Sincipitis*; juſt behind the Orbit of the Eye: From which Gland lieth a Duct, that conveys the Poyſon to the Bags at the Teeth.

The Teeth are tubulated, for the Conveyance, or Emiſſion of the Poyſon into the Wound the Teeth make; but their Hollowneſs doth not reach to the *Apex*, or Top of the Tooth, (that being ſolid and ſharp, the better to pierce;) but it ends in a long ſlit below the Point, out of which the Poyſon is emitted. Theſe Perforations of the Teeth, *Galen* ſaith, the Mountebanks us'd to ſtop with ſome kind of Paſte, before they ſuffer'd the Vipers to bite them before their Spectators. Cuts of theſe Parts, &c. may be ſeen in the laſt cited Book of Dr. *Mead*. Alſo Dr. *Tyſon's Anat. of the Rattle-Snake*, in *Phil. Tranſ.* No. 144.

(*i*) That Vipers have their great Uſes in Phyſick, is manifeſt from their bearing a great Share in ſome of our beſt Antidotes, ſuch as *Theriaca Andromachi*, and others; alſo in the Cure of the *Elephantiaſis*, and other the like ſtubborn Maladies, for which I ſhall refer to the medical Writers. But there is ſo ſingular a Caſe in the curious Collection of Dr. *Olaus*

born Diſeaſes; however, if they were not, there would be no Injuſtice for God to make a Set of ſuch noxious Creatures, as Rods and Scourges, to execute the Divine Chaſtiſements upon ungrateful and ſinful Man. And I am apt to think that the Nations which know not God, are the moſt annoy'd with thoſe noxious Reptiles, and other pernicious Crea-

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Worm. related from *Kircher*, that I ſhall entertain the Reader with it. Near the Village of *Saſſa*, about eight Miles from the City *Bracciano* in *Italy*, ſaith he, *Specus ſeu caverna (vulgò La Grotta delli Serpi) duorum hominum capax, fiſtuloſis quibuſdam foraminibus in formam cibri perforata cernitur, ex quibus ingens quædam, principio veris, diverſicolorum Serpentum, nullâ tamen, ut dicitur, ſingulari veneni qualitate imbutorum progenies quotannis pullulare ſolet. In hâc ſpeluncâ Elephantiacos, Leproſos, Paralyticos, Arthriticos, Podagricos, &c. nudos exponere ſolent, qui mox halituum ſubterraneorum calore in ſudorem reſoluti, Serpentum propullulantium, totum corpus infirmi implicantium, ſuctu linctuque ita omni vitioſo virulentoque humore privare dicuntur, ut repetito hoc per aliquod tempus medicamento, tandem perfectæ ſanitati reſtituantur.* This Cave *Kircher* viſited himſelf, found it warm, and every Way agreeable to the Deſcription he had of it; he ſaw their Holes, heard a murmuring hiſſing Noiſe in them; but although he miſſed ſeeing the Serpents, (it being not the Seaſon of their creeping out) yet he ſaw great Numbers of their *Exuviæ*, or *Sloughs*, and an Elm growing hard by laden with them.

The Diſcovery of this Cave, was by the Cure of a *Leper* going from *Rome* to ſome Baths near this Place; who loſing his Way, and being benighted, happened upon this Cave; and finding it very warm, pull'd off his Clothes, and being weary and ſleepy, had the good Fortune not to feel the Serpents about him till they had wrought his Cure. *Vide Muſeum Worm. l.* 3. *c.* 9.

The before-commended Dr. *Mead*, thinks our Phyſicians deal too cautiouſly and ſparingly, in their preſcribing only ſmall Quantities of the Viper's Fleſh, *&c.* in the *Elephantiaſis*, and ſtubborn *Leproſies:* But he recommendeth rather the Gelly or Broth of Vipers; or, as the Ancient Manner was, to boil Vipers, and eat them like Fiſh; or at leaſt to drink Wine, in which they have been long infuſed. *Vide Mead. ubi ſupra, p.* 34.

(*k*) That

Creatures. As to the Animals themſelves, their Poiſon is, no doubt, of ſome great and eſpecial Uſe to themſelves, ſerving to the more eaſy Conqueſt, and ſure Capture of their Prey, which might otherwiſe be too reſty and ſtrong, and if once eſcap'd, would hardly be again Recover'd, by Reaſon of their ſwifter Motion, and the Help of their Legs; beſides all which, this their Poiſon may be probably of very great Uſe to the Digeſtion of their Food.

And as to the innocuous Part of the Reptile-Kind, they as well deſerve our Notice for their Harmleſneſs, as the others did for their Poiſon. For as thoſe are endow'd with Poiſon, becauſe they are predaceous; ſo theſe need it not, becauſe their Food is near at Hand, and may be obtain'd without Strife and Conteſt, the next Earth (*k*) affording Food to ſuch as can terebrate, and make Way into it by their Vermicular Faculty; and the next Vegetable being Food to others that can climb and reach (*l*), or but crawl to it.

(*k*) That *Earth-worms* live upon Earth, is manifeſt from the little curled Heaps of their Dung ejected out of their Holes. But in *Philoſ. Tranſ.* No. 291, I have ſaid, it is in all Probability Earth made of rotted Roots and Plants, and ſuch like nutritive Things, not pure Earth. And there is farther Reaſon for it, becauſe Worms will drag the Leaves of Trees into their Holes.

(*l*) *Snails* might be in Danger of wanting Food, if they were to live only upon ſuch tender Plants as are near the Ground, within their Reach only; to impower them therefore to extend their Purſuits farther, they are enabled by the Means mentioned in *Note* (*d*), to ſtick unto, and creep up Walls and Vegetables at their Pleaſure.

CHAP. II.

Of the Inhabitants of the Waters.

I Have now gone through that Part of the Animal World, which I propoſed to ſurvey, the Animals inhabiting the Land.

As to the other Part of the Terraqueous Globe, the Waters, and the Inhabitants thereof, not having Time to finiſh what I have begun on that large Subject, I ſhall be forced to quit it for the preſent, altho' we have there as ample and glorious a Scene of the Infinite Creator's Power and Art, as hath been already ſet forth on the dry Land. For the Waters themſelves are an Admirable Work of God (*a*), and of Infinite Uſe (*b*) to that

(*a*) Beſides their abſolute Neceſſity, and great Uſe to the World, there are ſeveral Topics, from whence the Waters may be demonſtrated to be God's Work; as, the creating ſo vaſt a Part of our Globe; the placing it commodiouſly therein, and giving it Bounds; the Methods of keeping it ſweet and clean, by its Saltneſs, by the Tides, and Agitations by the Winds; the making the Waters uſeful to the Vegetation of Plants, and for Food to Animals, by the noble Methods of ſweetning them; and many other Things beſides, which are inſiſted on in that Part of my Survey.

(*b*) *Pliny* having named divers *Mirabilia Aquarum*, to ſhew their Power; then proceeds to their Uſes, viz. *Eædem cadentes omnium terrâ naſcentium cauſa fiunt, prorſus mirabili naturâ, ſiquis velit reputare, ut fruges gignantur, arbores fruticeſque vivant, in cœlum migrare aquas, animamque etiam herbis vitalem inde deferre: juſtâ confeſſione, omnes terræ quoque vires aquarum eſſe beneficii. Quapropter ante omnia ipſarum potentiæ exempla ponemus: Cunctas enim quis mortalium enumerare queat?* And then he goes on with an Enumeration of ſome Waters famed for being Medicinal, or ſome other unuſual Quality, *Plin. l.* 31, *c.* 1, & 2.

(*c*) *Pliny*

that Part of the Globe already ſurvey'd; and the prodigious Variety (*c*), and Multitudes of curious and wonderful Things obſervable in its Inhabitants of all Sorts, are an inexhauſtible Scene of the Creator's Wiſdom and Power. The vaſt Bulk of ſome (*d*), and prodigious Minuteneſs of others (*e*), together with the incomparable Contrivance and Structure of the Bodies (*f*) of all; the Proviſions and Supplies of Food afforded to ſuch an innumerable Company of Eaters, and that in an Element, unlikely, one would think, to afford any great Store of

(*c*) *Pliny* reckons 176 Kinds in the Waters, whoſe Names may be met with in his *l.* 32. *c.* 11. but he is ſhort in his Account.

(*d*) *Pliny*, *l.* 9. *c.* 3. ſaith, That in the *Indian* Sea there are *Balenæ quaternûm jugerum* (*i. e.* 960 Feet) *Priſtes* 200 *cubitorum* (*i. e.* 300 Feet.) And *l.* 32. *c.* 1. he mentions *Whales* 600 Feet long, and 360 broad, that came into a River of *Arabia*. If the Reader hath a Mind, he may ſee his Reaſon why the largeſt Animals are bred in the Sea, *l.* 9. *c.* 2.

(*e*) As the largeſt, ſo the moſt minute Animals are bred in the Waters, as thoſe in Pepper-water; and ſuch as make the green Scum on the Waters, or make them ſeem as if green, and many others. See *Book* IV. *Chap.* 11. *Note* (*n*), (*o*).

(*f*) It might be here ſhewn, that the Bodies of all the ſeveral Inhabitants of the Waters, are the beſt contrived and ſuited to that Place and Buſineſs in the Waters, which is proper for them; that particularly their Bodies are cloathed and guarded, in the beſt Manner, with Scales, or Shells, *&c.* ſuitable to the Place they are to reſide in, the Dangers they may there be expoſed unto, and the Motion and Buſineſs they are there to perform: That the Center of Gravity (of great Conſideration in that fluid Element,) is always plac'd in the fitteſt Part of the Body: That the Shape of their Bodies, (eſpecially the more ſwift,) is the moſt commodious for making Way through the Waters, and moſt agreeable to geometrical Rules; and many other Matters beſides would deſerve a Place here, were they not too long for Notes, and that I ſhall anticipate what ſhall be more proper for another Place, and more accurately treated of there.

of Supplies (*g*); the Buſineſs of Reſpiration perform'd in a Way ſo different from, but equivalent to what is in Land Animals (*h*); the Adjuſtment of the Organs of Viſion (*i*) to that Element in which the Animal liveth; the Poiſe (*k*), the Support (*l*), the Motion of the Body (*m*), forwards with

(*g*) See before *Book* IV. *Chap.* 11.

(*h*) *Galen* was aware of the Reſpiration of Fiſhes by their *Branchiæ*. For having ſaid, that Fiſhes have no Occaſion of a Voice, neither reſpire through the Mouth as Land Animals do, he ſaith, *Sed earum, quas Branchias nuncupamus, conſtructio, ipſis vice Pulmonis eſt. Cum enim crebris ac tenuibus foraminibus ſint Branchiæ hæ interceptæ, aëri quidem & vapori perviis, ſubtilioribus tamen quàm pro mole aquæ; hanc quidem extra repellunt, illa autem promptè intromittunt.* Galen de Uſ. Part. l. 6. c. 9. So alſo *Pliny* held, That Fiſhes reſpired by their Gills; but he ſaith *Ariſtotle* was of a different Opinion. *Plin. l.* 9. *c.* 7. And ſo *Ariſtotle* ſeems to be in his *Hiſtory of Animals*, *l.* 8. *c.* 2. and in other Places. And I may add our famous Dr. *Needham*. See his *De form. Fœtu*, *Chap.* 6. and *Anſwer to* Severinus.

(*i*) A protuberant Eye would have been inconvenient for Fiſhes, by hindring their Motion in ſo denſe a Medium as Water is; or elſe their bruſhing through ſo thick a Medium would have been apt to wear, and prejudice their Eyes; therefore their *Cornea* is flat. To make Amends for which, as alſo for the Refraction of Water, different from that of the Air, the Wiſe Contriver of the Eye, hath made the *Cryſtalline* ſpherical in Fiſhes, which in Animals, living in the Air, is *lenticular*, and more flat.

(*k*) As I have ſhewed before, that the Bodies of Birds are nicely pois'd to ſwim in the Air; ſo are thoſe of Fiſhes for the Water, every Part of the Body being duly balanc'd, and the Center of Gravity (as I ſaid in *Note* (*f*), accurately fix'd. And to prevent Vacillation, ſome of the Fins ſerve, particularly thoſe of the Belly; as *Borelli* prov'd, by cutting off the Belly-fins, which caus'd the Fiſh to reel to the right and left Hand, and render'd it unable to ſtand ſteadily in an upright Poſture.

(*l*) To enable the Fiſh to abide at the Top, or Bottom, or any other Part of the Waters, the Air-Bladder is given to moſt Fiſhes, which as it is more full or empty, makes the Body more or leſs buoyant.

(*m*) The

with great Swiftneſs, and upwards and downwards with great Readineſs and Agility, and all without Feet and Hands, and ten thouſand Things beſides; all theſe Things, I ſay, do lay before us ſo various, ſo glorious, and withal ſo inexhauſtible a Scene of the Divine Power, Wiſdom and Goodneſs, that it would be in vain to engage my ſelf in ſo large a Province, without alotting as much Time and Pains to it, as the preceding Survey hath coſt me. Paſſing by therefore that Part of our Globe, I ſhall only ſay ſomewhat very briefly concerning the *inſenſitive* Creatures, particularly thoſe of the *vegetable Kingdom*, and ſo conclude this Survey.

(*m*) The *Tail* is the grand Inſtrument of the Motion of the Body; not the Fins, as ſome imagine. For which Reaſon, Fiſhes are moſt muſculous and ſtrong, in that Part, than in all the reſt of their Body, according as it is in the motive Parts of all Animals, in the pectoral Muſcles of Birds, the Thighs of Man, *&c.*

If the Reader hath a Mind to ſee the admirable Method, how Fiſhes row themſelves by their Tail, and other Curioſities relating to their Swimming; I ſhall refer him to *Borelli de mot. Animal. Part* 1. *Chap.* 23. particularly to *Prop.* 213.

BOOK X.

Of VEGETABLES.

THE Vegetable Kingdom, although an inferior Branch of the Creation, exhibits to us ſuch an ample Scene of the Creator's Contrivance, Curioſity, and Art, that I much rather

ther chuſe to ſhew what might be ſaid, than engage too far in Particulars. I might inſiſt upon the great Variety there is, both of Trees and Plants provided for all Ages, and for every Uſe and Occaſion of the World (*a*); ſome for Building, for Tools and Utenſils of every Kind; ſome hard, ſome ſoft; ſome tough and ſtrong, ſome brittle; ſome long and tall, ſome ſhort and low; ſome thick and large, ſome ſmall and ſlender; ſome for Phyſick (*b*), ſome for Food, ſome for Pleaſure; yea, the moſt abject (*c*) Shrubs, and the very Buſhes

(*a*) The fifth Book of *Theophraſtus's History of Plants* may be here conſulted; where he gives ample Inſtances of the various Conſtitutions and Uſes of Trees, in various Works, &c. See alſo before, *Book* IV. *Chap.* 13. *Note* (*a*).

(*b*) *Inviſis quoque herbis inſeruit* [Natura] *remedia: quippe cum medicinas dederit etiam aculeatis——in quibus ipſis providentiam Naturæ ſatis admirari amplectique non eſt.——Inde excogitavit aliquas aſpectu hiſpidas, tactu truces, ut tantum non vocem ipſius fingentis illas, rationemque reddentis exaudire videamur, ne ſe depaſcat avida Quadrupes, ne procaces manus rapiant, ne neglecta veſtigia obterant, ne inſidens Ales infringat: his muniendo Aculeis, teliſque armando, remediis ut tuta ac ſalva ſint. Ita hoc quoque quod in iis odimus, hominum cauſa excogitatum.* Plin. Nat. Hiſt. l. 22. c. 6.

Are ſome of the Species of Nature noxious? They are alſo uſeful.——Doth a Nettle ſting? It is to ſecure ſo good a Medicine from the Rapes of Children and Cattle. Doth the Bramble cumber a Garden? It makes the better Hedge; where if it chanceth to prick the Owner, it will tear the Thief. Grew. Coſmolog. lib. 3. cap. 2. ſect. 47.

(*c*) That the moſt abject Vegetables, &c. have their Uſe, and are beneficial to the World, may in ſome Meaſure appear from the Uſe the Northern People put rotten Wood, &c. unto. *Satis ingenioſum modum habent populi ſeptentrionales in nemoribus nocturno tempore pertranſeuntes, imo & diurno, quando in remotioribus Aquilonis partibus ante, & poſt Solſtitium hyemale continuæ noctes habentur. Quique his remediis indigent, Cortices quercinos inquirunt putres, oaſque collocant certo interſtitio itineris inſtituti, ut eorum ſplendore, quo voluerint, perficiant iter. Nec ſolum hoc præſtat Cortex, ſed & Truncus putrefactus, ac fungus ipſe Agaricus appellatus,* &c. Ol. Mag. Hiſt. l. 2. c. 16.

To

Buſhes and Brambles themſelves, the Husbandman can teſtify the Uſe of.

I might alſo Survey here the curious Anatomy and Structure of their Bodies (*d*), and ſhew the admirable Proviſion made for the Conveyance of the lymphatick and eſſential Juices, for communicating the Air, as neceſſary to Vegetable, as Animal Life (*e*): I might alſo ſpeak of, even the very Covering

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To this we may add *Thiſtles* in making Glaſs, whoſe Aſhes Dr. *Merret* ſaith, are the beſt, *viz.* the Aſhes of the *Common-way Thiſtle*, though all *Thiſtles* ſerve to this Purpoſe. Next to *Thiſtles* are *Hop-ſtrings*, cut after the Flowers are gathered. Plants that are Thorny and Prickly, ſeem to afford the beſt and moſt Salt. *Merret's Obſervations on Anton. Ner. p.* 265.

Quid majora ſequar? Salices, humileſque Geniſtæ,
Aut illæ pecori frondem, aut paſtoribus umbram
Sufficiunt, Sepemque ſatis, & pabula melli.

Virg. Georg. lib. 2. ver. 434.

(*d*) Dr. *Beal* (who was very curious, and tried many Experiments upon Vegetables) gives ſome good Reaſons to imagine, that there is a direct Communication between the Parts of the Tree and the Fruit, ſo that the ſame Fibres which conſtitute the Root, Trunk, and Boughs, are extended into the very Fruit. And in old *Horn-beams*, I have obſerved ſomething very like this; in many of which, there are divers great and ſmall Ribs (almoſt like Ivy, only united to the Body) running from the Root up along the outſide of the Body, and terminating in one ſingle, or a few Boughs: Which Bough or Boughs ſpread again into Branches, Leaves, and Fruit. See what Dr. *Beal* hath in *Lowth. Abridg.* Vol. 2. p. 710.

But as to the particular Canals, and other Parts relating to the Anatomy of Vegetables, it is too long a Subject for this Place, and therefore I ſhall refer to *Seign. Malpighi's* and Dr. *Grew's* Labours in this Kind.

(*e*) *Tanta eſt Reſpirationis neceſſitas, & uſus, ut Natura in ſingulis viventium ordinibus varia, ſed analoga, paraverit inſtrumenta, quæ Pulmones vocamus* [and ſo he goes on with obſerving the *Apparatus* made in the various *Genera* of Animals, and then ſaith] *In Plantis verò, quæ infimum animalium attingunt ordinem, tantam*

Trachea-

Covering they are provided with, becauſe it is a curious Work in Reality, although leſs ſo in Appearance: And much more therefore might I ſurvey the neat Variety and Texture of their Leaves (*f*), the

Trachearum copiam & productionem extare par eſt, ut his minimæ Vegetantium partes præter corticem irrigentur.——Plantæ igitur (ut conjectari fas eſt) cùm ſint viventia, viſcéribus infixa terræ, ab hac, ſeu potius ab aquâ & aëre, commixtis & percolatis à terrâ, Reſpirationis ſuæ materiam recipiunt, ipſarumque Trachea ab halitu terræ, extremas radices ſubingreſſo, replentur. Malpig. Op. Anat. Plant. p. 15.

Theſe *Trachea* or *Air-Veſſels*, are viſible, and appear very pretty in the Leaf of *Scabious*, or the Vine, by pulling aſunder ſome of its principal Ribs, or great Fibres; between which, may be ſeen the Spiral *Air-Veſſels* (like Threads of Cob-web) a little uncoiled: A Figure whereof, Dr. *Grew* hath given us in his *Anat. Plant. Tab.* 51, 52.

As to the curious coiling, and other Things relating to the Structure of thoſe *Air-Veſſels*, I refer to *Malpig. p.* 14. and Dr. *Grew*, *ib. l.* 3. *c.* 3. *ſect.* 16, *&c.* and *l.* 4. *c.* 4. *ſect.* 19, of Mr. *Ray*, from them ſuccinctly. *Hiſt. Plant. l.* 1. *c.* 4.

(*f*) Concerning the *Leaves*, I ſhall Note only two or three Things. 1. As to the *Fibres of the Leaf*, they ſtand not in the *Stalk*, in an even Line, but always in an Angular, or Circular Poſture, and their vaſcular Fibres or Threads, are 3, 5, or 7. The Reaſon of their Poſition thus, is for the more erect Growth and greater Strength of the Leaf, as alſo for the Security of its Sap. Of all which ſee Dr. *Grew*, *l.* 1. *c.* 4. *ſect.* 8, *&c.* and *l.* 4. *par.* 1. *c.* 3. alſo *Tab.* 4. *Fig.* 2, to 11. Another Obſervable in the Fibres of the Leaf, is their orderly Poſition, ſo as to take in an eighth Part of a Circle, as in *Mallows*; in ſome a tenth, but in moſt a twelfth, as in *Holy-Oak*; or a ſixth, as in *Syringa*. *Id. ib. Tab.* 46, 47.

2. The Art in *Folding up the Leaves* before their Eruption out of their Gems, *&c.* is incomparable, both for its Elegancy and Security, *viz. In taking up (ſo as their Forms will bear) the leaſt Room; and in being ſo conveniently couched as to be capable of receiving Protection from other Parts, or of giving it to one another*, e.g. *Firſt, there is the Bow-lap, where the Leaves are all laid ſomewhat convexly one over another, but not plaited——but where the Leaves are not ſo thick ſet, as to ſtand in the Bow-lap, there we have the Plicature, or the Flat-lap; as in Roſe-trees*, &c. And ſo that curious Ob-

the admirable Finery, Gaiety, and Fragrancy of their Flowers (*g*). I might alſo inquire into the wonderful Generation and Make of the Seed (*h*), and

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Obſerver goes on ſhewing the various Foldings, to which he gives the Names of the *Duplicature*, *Multiplicature*, the *Fore-rowl*, *Back-rowl*, and *Tre-rowl*, or *Treble-rowl*. *Grew. ib. l.* 1. *c.* 4. *ſect.* 14, *&c.* To theſe he adds ſome others. *l.* 4. *P.* 1. *c.* 1. *ſect.* 9. Conſult alſo *Malpig. de Gemmis*, *p.* 22, *&c.*

To theſe curious Foldings, we may add another noble Guard by the Interpoſition of *Films*, *&c.* of which Dr. *Grew* ſaith, there are about ſix Ways, *viz. Leaves*, *Surfoils*, *Interfoils*, *Stalks*, *Hoods*, and *Mantlings*. *Grew*, *ib.* and *Tab.* 41, 42. *Malpig. ibid.*

(*g*) In the *Flower* may be conſidered the *Empalement*, as Dr. *Grew*; the *Calix*, or *Perianthium*, as Mr. *Ray*, and others, call it, deſigned to be a Security, and Bands, to the other Parts of the Flower. *Floris velut baſis & fulcimentum eſt.* Ray Hiſt. l. 1. c. 10. Flowers, whoſe *Petala* are ſtrong (as Tulips) have no *Calix*. *Carnations*, whoſe *Petala* are long and ſlender, have an Empalement of one Piece: And others, ſuch as the *Knap-weeds*, have it conſiſting of ſeveral Pieces, and in divers Rounds, and all with a counterchangeable Reſpect to each other, for the greater Strength and Security of themſelves, and the *Petala*, &c. they include.

The next is the *Foliation*, as Dr. *Grew*, the *Petala*, or *Folia*, as Mr. *Ray*, and others. In theſe, not only the admirable Beauty, and luxuriant Colours are obſervable, but alſo their curious *Foldings* in the *Calix*, before their Expanſion. Of which Dr. *Grew* hath theſe Varieties, *viz.* The *Cloſe-Couch*, as in *Roſes*; the *Concave-Couch*, as in *Blattaria flore albo*; the *Single-Plait*, as in *Peaſe-Bloſſoms*; the *Double-Plait*, as in *Blue-Bottles*, &c. the *Couch* and *Plait* together, as in *Marigolds*, &c. the *Rowl*, as in *Ladies-Bower*; the *Spire*, as in *Mallows*; and laſtly, the *Plait* and *Spire* together, as in *Convolvulus Doronici folio*. *Lib.* 1. *cap.* 5. *ſect.* 6. and *Tab.* 54.

As to the *Stamina* with their *Apices*, and the *Stylus*, (called the *Attire*, by Dr. *Grew*,) they are admirable, whether we conſider their Colours, or Make, eſpecially their Uſe, if it be as Dr. *Grew*, Mr. *Ray*, and others imagine, namely, as a *Male Sperm*, to impregnate and fructify the Seed. Which Opinion is corroborated by the ingenious Obſervations of Mr. *Samuel Morland*, in *Philoſ. Tranſ.* No. 287.

Reliqua

and the great Uſefulneſs of their Fruit: I might ſhew that the Rudiments and Lineaments of the Parent-Vegetable, though never ſo large and ſpacious, is locked up in the little Compaſs of their Fruit or Seed, though ſome of theſe Seeds are ſcarce viſible to the naked Eye (*i*). And foraſmuch as the

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Reliqua uſûs alimentique gratiâ genuit [Natura] *ideoque ſecula annoſque tribuit iis. Flores verò odoreſque in diem gignit: magnâ (ut palam eſt) admonitione hominum, quæ ſpectatiſſimè floreant, celerrimè marceſcere.* Plin. Nat. Hiſt. l. 21. c. 1.

(*h*) As to the curious and gradual Proceſs of Nature in the Formation of the Seed or Fruit of Vegetables, Cuts being neceſſary, I ſhall refer to Dr. *Grew*, *p.* 45, and 209, and *Malpig. p.* 57.

(*i*) *Vetus eſt Empedoclis dogma, Plantarum ſemina Ova eſſe, ab iiſdem decidua——Ineſt in eo* [Ovo vel Semine) *velut in cicatrice, non ſolo viventis carina, ſed cum minimo trunco aſſurgentes partes, Gemma ſcilicet, & inſignis radicis Canus, &c.* Malpig. ib. p. 81. vid. plura in tract. *de Seminum veget.* p. 14. & paſſim.

In *Malpighi*'s Life, a Debate may be ſeen between him and *Seign. Triumphetti*, the Provoſt of the Garden at *Rome*, whether the whole Plant be actually in the Seed. The Affirmative is maintained by *Malpighi*, with cogent Arguments; among which, this is one: *Non præoccupatâ mente, oculis microſcopio armatis, luſtret quæſo Phaſeolorum, ſeminalem plantulam nondum ſatam, in quâ folia ſtabilia, hæque ampla evidenter obſervabit; in eâdem pariter gemmam, nodos, ſeu implantationes varias foliorum caulis deprehendet. Caulem inſignem fibris ligneis, & utriculorum ſeriebus conſtantem conſpicuè attinget.* And whereas *S. Triumphetti* had objected, that *vegetatione, metamorphoſi, inediâ plantas in alias degenerare, ut exemplo plurium* [conſtat] *præcipuè tritici in lolium, & lolii in triticum verſi.* In Anſwer to this, (which is one of the ſtrongeſt Arguments againſt *Malpighi*'s Aſſertion) *Malpighi* replies, *Nondum certum eſt de integritate, & ſucceſſu experimenti, nam facienti mihi, & amicis, tritici metamorphoſis non ceſſit. Admiſſa tamen metamorphoſi, quoniam hæc neglecta cultura, aut vitio ſoli, aut aëris contingit——ideo ex morboſo & monſtruoſo affectu non licet inferre permanentem ſtatum à Natura intentum. Obſervo plantas ſylveſtres cultura varias reddi, &c.* I have more largely taken Notice of *Malpighi*'s Anſwer, becauſe he therein ſhews his Opinion about the Tranſmutation of Vegetables. *Vid. Malpig. Vit. p.* 67.

So

the Perpetuity and Safety of the Species depends upon the Safety of the Seed and Fruit in a great Mea-

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So Mr. *Lewenhoeck*, after his nice Obſervations of an *Orange-Kernel*, which he made to germinate in his Pocket, &c. concludes, *Thus we ſee, how ſmall a Particle, no bigger than a courſe Sand* (as the Plant is repreſented) *is increaſed*, &c. *A plain Demonſtration, that the Plant, and all belonging to it, was actually in the Seed, in the young Plant, its Body, Root, &c.* Philoſ. Tranſ. No. 287. See alſo *Raii Cat. Cant.* in *Acer. maj.* from Dr. *Highmore*. But in all the Seeds which I have viewed, except the *Maple*, the Plant appears the plaineſt to the naked Eye, and alſo very elegant, in the *Nux Vomica*.

Natura non obſervat magnitudinis proportionem inter ſemina & plantas ab iiſdem ortas, ita ut majus ſemen majorem ſemper producat plantam, minus minorem. Sunt enim in genere herbarum non pauca, quarum ſemina arborum nonnullarum ſeminibus non dico æqualia ſunt, ſed multo majora, Sic v. g. *Semina Fabæ, &c. ſemina Ulmi, &c. multis vicibus magnitudine ſuperant.* Raii ubi ſuprà, l. 1. c. 13.

Filicem reliquaſque Capillares herbas Semine carere Veteres plerique ——prodidere; quos etiam ſecuti ſunt è Recentioribus nonnulli, Dodonæus, &c. ——Alii è contrà, Bauhinus, &c. Filices & congeneres ſpermatophoras eſſe contendunt; Partim quia Hiſtoria Creationis, Geneſ. ii. 12, &c. *——Hanc ſententiam veriſſimam eſſe ——autopſia convincit. Fredericus Cæſius*, he ſaith, was the firſt that diſcovered theſe Seeds with the Help of a Microſcope. And ſince him, Mr. *W. C.* hath more critically obſerved them. Among other Things obſerved by that ingenious Gentleman, are theſe, *Pixidulæ ſeu capſulæ ſemina continentes in pleriſque hoc genus plantis perquam exili granulo arenæ vulgaris cinereæ plus duplo minores ſunt; imò in nonnullis ſpeciebus vix tertiam quartamve arenulæ partem magnitudine æquant, veſicularum quarundam annulis aut faſciolis vermiformibus obvolutarum ſpeciem exhibentes. Nonnullæ ex his veſiculis* 100 *circiter ſemina continere deprehendebantur ——adeò eximiâ parvitate ut nudo oculo prorſus eſſent inviſibilia, nec niſi microſcopii interventu detegi poſſent. ——Oſmunda Regalis, quæ aliis omnibus Filicis ſpeciebus mole ——antecellit ——vaſcula ſeminalia obtinet æquè cum reliquis congeneribus magnitudinis ——quorum immenſa & viſum fugiens parvitas cum magnitudine plantæ collata ——adeò nullam gerere proportionem invenietur, ut tantam plantam è tantillo ſemine produci attentum obſervatorem meritò in admirationem rapiat.* Ray, ibid. l. 3. p. 132. This *W. C.* was Mr. *Wil. Cole*, as he owneth in a Letter I have now in my Hands of his to Mr. *Ray*, of *Octob.* 18. 1684.

(*k*) *Vege-*

Meaſure, I might therefore take Notice of the peculiar Care the Great God of Nature hath taken for the Conſervation and Safety hereof: As particularly in ſuch as dare to ſhew their Heads all the Year, how ſecurely their Flower, Seed or Fruit is locked up all the Winter, together with their Leaves and Branches, in their Gems (*k*), and well fenced and covered there with neat and cloſe Tunicks. And for ſuch as dare not ſo to expoſe themſelves, with what Safety are they preſerved under the Coverture of the Earth, in their Root (*l*), Seed

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(*k*) *Vegetantium genus, ut debitam magnitudinem ſortiatur, & ſuæ mortalitatis jacturam ſucceſſivâ prolis eductione reparet, ſtatis temporibus novas promit partes, ut tandem emergentes Uteri, recentes edant Soboles. Emanantes igitur à caule, caudice, ramis, & radicibus novellæ hujuſmodi partes, non illico laxatæ extenduntur, ſed compendio quodam coagmentatæ intra folii axillam cubantes, non parum ſubſiſtunt, Gemmæ appellantur, &c.* And then that great Man goes on to ſhew the admirable various Methods of Nature, in repoſiting in that little Compaſs, ſo large a Part of a Tree or Plant, the curious Structure of the Gems, the admirable Guard afforded them, and the Leaves, Flowers and Seed contained in them, *&c.* Of which having taken Notice before, I paſs over it now, and only refer to our Author *Malpighi*, and Dr. *Grew*, in the Places cited in *Note* (*f*) and (*g*).

(*l*) Of *Bulbous*, and a great many more, probably of the far greater Number of *Perennial Roots* of Herbs, as *Arum*, *Rape-Crowfoot*, *&c.* it is very obſervable, that their Root is annually renewed, or repaired out of the Trunk or Stalk it ſelf; that is to ſay, the *Baſis* of the *Stalk* continually, and by inſenſible Degrees deſcending below the Surface of the Earth, and hiding it ſelf therein, is thus both in Nature, Place and Office, changed into a true Root. ——So in *Brownwort*, the Baſis of the Stalk ſinking down by Degrees, till it lies under Ground, becomes the upper Part of the Root; and continuing ſtill to ſink, the next Year becomes the lower Part: And the next after that, rots away; a new Addition being ſtill yearly made out of the Stalk, as the elder Parts yearly rot away. *Grew, ibid. l. 2. p. 59. ubi plura vid.*

(*m*) How

Seed (*m*), or Fruit, till invited out by the kindly Warmth of the Spring! And when the whole Vegetable Race is thus called out, it is very pretty to obſerve the Methods of Nature in guarding thoſe inſenſitive Creatures againſt Harms and Inconveniencies, by making ſome (for Inſtance) to lie down proſtrate, and others, to cloſe themſelves up (*n*) upon the Touch of Animals, and the moſt to ſhut up their Flowers, their Down (*o*), or other their like

(*m*) How ſafe and agreeable a Conſervatory the Earth is to Vegetables, more than any other, is manifeſt from their rotting, drying, or being rendred infecund in the Waters, or the Air; but in the Earth their Vigour is long preſerved. Thus Seeds particularly, Mr. *Ray* thinks ſome, may probably retain their Fecundity for ten Years, and others loſe it in five; but, ſaith he, *In terræ gremio latitantia, quamvis tot caloris, frigoris, humoris & ſiccitatis varietatibus ibidem obnoxia, diutiùs tamen (ut puto) fertilitatem ſuam tuentur quàm ab hominibus diligentiſſimè cuſtodita; nam & ego & alii ante me multi obſervârunt Sinapeos vim magnam enatam in aggeribus foſſarum recèns factis inque areis gramineis effoſſis, ubi poſt hominum memoriam nulla unquam Sinapeos ſeges ſuccreverat. Quam tamen non ſpontè ortam ſuſpicor, ſed è ſeminibus in terra per tot annos reſiduis etiam prolificis.* Ray. Hiſt. Pl. l. 1. c. 13.

(*n*) *Plantæ nonnullæ Æſchynomenæ Veteribus dictæ, Recentioribus Vivæ, & Senſitivæ, & Mimoſæ, haud obſcura ſenſûs indicia prodùnt; ſiquidem folia earum manu aut baculo tacta, & paululum compreſſa, pleno etiam meridie, ſplendente Sole, illicò ſe contrahunt; in nonnullis etiam ſpeciebus cauliculi teneriores concidunt & velut mareſcunt; quod idem ab aëre frigidiore admiſſa patiuntur.* Ray Hiſt. Pl. T. 1. L. 18. App. S. 2. c. 2. p. 978.

(*o*) I have obſerved that many, if not moſt Vegetables, do expand their Flowers, Down, &c. in warm, Sun-ſhiny Weather, and again cloſe them towards Evening, or in Rain, &c. eſpecially at the Beginning of Flowering, when the Seed is young and tender; as is manifeſt in the Down of *Dandelion*, and other Downs; and eminently in the Flowers of *Pimpernel*; the opening and ſhutting of which, are the Country-Man's Weather-wiſer; whereby *Gerard* ſaith, he foretelleth what Weather ſhall follow the next Day; for, ſaith he, *If the Flowers be cloſe ſhut up, it betokeneth Rain and foul Weather;*

like Guard, upon the Close and Cool of the Evening, by Means of Rain, or other Matters that may be prejudicial to the tender Seed.

And now to these Considerations relating to the Seed, I might add the various Ways of Nature in dissipating and sowing it, some being for this end, winged with light Down, or Wings, to be conveyed about by the Winds; others being laid in elastick, springy Cases, that when they burst and crack, dart their Seed at convenient Distances, performing thereby the Part of a good Husbandman (*p*); others by their agreeable Taste and Smell,

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contrarywise, if they be spread abroad, fair Weather. Ger. Herb. B. 2. c. 183.

Est & alia [arbor in Tylis] *similis, foliosior tamen, roseique floris; quem noctu comprimens, aperire incipit Solis exortu, meridie expandit. Incolæ dormire eam dicunt.* Plin. Nat. Hist. l. 12. c. 11.

(*p*) *So soon as the Seed is ripe, Nature taketh several Methods for its being duly Sown; not only in the opening of the* Uterus, *but also in the Make of the Seed it self. For, First, The Seeds of many Plants, which affect a peculiar Soil or Seat, as of* Arum, Poppy, &c. *are heavy and small enough, without farther Care, to fall directly down into the Ground* ——*But if they are so large and light, as to be expos'd to the Wind, they are often furnish'd with one or more Hooks, to stay them from straying too far from their proper Place*——*So the Seeds of* Avens *have one single Hook; those of* Agrimony *and* Goosegrass, *many; both the former loving a warm Bank; the latter, an Hedge for its Support. On the contrary, many Seeds are furnish'd with Wings or Feathers; partly with the Help of the Wind to carry them, when ripe, from off the Plant, as of* Ash, &c.——*and partly to enable them to make their Flight more or less abroad, that so they may not, by falling together, come up too thick; and that if one should miss a good Soil or Bed, another may hit. So the Kernels of* Pine *have Wings*——*yet short*——*whereby they fly not into the Air, but only flutter upon the Ground. But those of* Typha, Dandelion, *and most of the pappous Kind*——*have long numerous Feathers, by which they are wafted every Way.*——*Again, there are Seeds which are scatter'd not by flying abroad, but by being either spirted or flung away. The first of those are Wood-sorrel, which having a running Root, Nature sees fit to sow the Seeds at some Distance. The doing of which is effected by a white sturdy Cover,*

Cover, of a tendinous or ſpringy Nature.—This Cover, ſo ſoon as it begins to dry, burſts open on one Side, in an Inſtant, and is violently turn'd Inſide outward——and ſo ſmartly throws off the Seed. The Seeds of Hart's-tongue, *is ſlung or ſhot away——by the curious Contrivance of the Seed-caſe, as in* Codded-Aſmart, *only there the Spring moves and curls inward, but here outward,* viz. *Every Seed-Caſe——is of a ſpherick Figure, and girded about with a ſturdy Spring.——The Surface of the Spring reſembles a fine Skrew.——So ſoon as——this Spring is become ſtark enough, it ſuddenly breaks the Caſe into two Halfs, like two little Cups, and ſo ſlings the Seed.* Grew, ib. p. 199. and in *Tab.* 72. all theſe admirable Artifices are handſomely repreſented.

Quin ſi quantitas modica ſeminum (Filicis Phyllitidis quoque) *à foliis in ſubjectam chartæ mundæ——ſchedam decutiatur, detergatúrve, & deinde in acervum converratur, veſicularum ſeminalium plurimis unà diſſilientibus, & ſibi invicem alliſis, acervulus variè moveri per partes videbitur, non ſecus ac ſi Syrenibus aut iſtiuſmodi beſtiolis repletus eſſet——quin ſi locus tranquillus ſit, aure proximè admotâ, crepitantium inter rumpendum vaſculorum ſonitus——percipietur; & ſi microſcopio chartam oculis oberres, ſemina per eam undique ſparſa, & ad notabilem ab acervò diſtantiam projecta comperies.* Ray ibid. p. 132.

The admirable Contrivance of Nature, in this Plant is moſt plain. For the Seed-Veſſels being the beſt Preſerver of the Seed, 'tis there kept from the Injuries of Air and Earth, 'till it be rainy, when it is a proper Time for it to grow, and then it is thrown round the Earth, as Grain, by a skilful Sower.——When any Wet touches the End of the Seed-Veſſels, with a ſmart Noiſe and ſudden Leap it opens it ſelf, and with a Spring ſcatters its Seed to a pretty Diſtance round it, where it grows. Dr. Sloane Voy. to Jamaica, p. 150. of the *Gentianella flore cœruleo, &c.* or *Spirit-Leaf.*

The Plants of the *Cardamine-Family*, and many others, may be added here, whoſe Cods fly open, and dart out their Seed, upon a ſmall Touch of the Hand. But the moſt remarkable Inſtance is in the *Cardamine impatiens, cujus Siliquæ* (ſaith Mr. Ray) *vel leviter tactæ, actutùm ejaculantur* [Semina] *imò, quod longè mirabilius videtur, etſi ſiliquas non tetigeris, ſi tamen manum velut tacturus proximè admoveas, ſemina in approprinquantem evibrabunt; quod tum Moriſonus ſe ſæpius expertum ſcribit, tum Johnſtonus apud Gerardum verum eſſe affirmat.* Hiſt. Plant. l. 16. c. 20.

Neither is this Proviſion made only for Land Vegetables, but for ſuch alſo as grow in the Sea. Of which I ſhall give an Inſtance from my before-commended Friend, Dr. *Sloane. As to the Fuci,——their Seed hath been diſcover'd, (and ſhew'd me firſt,) by the Induſtry of the ingenious Herbariſt, Mr.* Sam. Doody, *who found on many of this Kind, ſolid Tubercules, or Riſings in ſome*

Smell, and ſalutary Nature, inviting themſelves to be ſwallow'd, and carry'd about by the Birds, and thereby alſo fertiliz'd by paſſing through their Bodies (*q*); and others not thus taken Care of, do many

Seaſons, wherein were lodg'd ſeveral round Seeds, as big as Muſtard-Seed, which, when ripe, the outward Membrane of the Tubercle breaking, leaveth the Seed to float up and down with the Waves. The Seed coming near Stones, or any ſolid Foundation, by Means of a Mucilage it carries with it, ſticks to them, and ſhoots forth Ligulæ *with Branches, and in Time comes to its Perfection and Magnitude.* Sloan Voy. Jamica, p. 50.

But although Mr. *Doody* had hinted, and conjectur'd at the Thing; yet the firſt that diſcover'd the Seeds in *Fuci*, was the before-commended Dr. *Tancred Robinſon*; as may be ſeen by comparing what Mr. *Ray* ſaith in his *Synopſ. Stirp. Brit. p.* 6. with his *Append. Hiſt. p.* 1849. Beſides which *Fuci*, the Dr. tells me, he obſerv'd Veſſels and Seed in *Coralloid Shrubs*, as alſo in ſeveral *Fungi*, not only in the Species of *Crepitus Lupi*, but alſo between the *Lamellæ* of other Species, and in that ſub-terraneous Kind call'd *Truffles*, whoſe Seed and Veſſels open in the Cortex, at ſome Seaſons he ſaith, like that of Mallows in Shape.

As to the *Crepitus Lupi*, I have more than once examin'd their Powder, with thoſe excellent Microſcopes of Mr. *Wilſon*'s Make: But the moſt ſatisfactory View Mr. *Wilſon* himſelf gave me; by which I found the Seeds to be ſo many exceeding ſmall *Puff-Balls*, with round Heads, and longer than ordinary ſharp-pointed Stalks, as if made on purpoſe to prick eaſily into the Ground. Theſe Seeds are intermix'd with much duſty Matter, and become hurtful to the Eyes, probably by their ſharp Stalks pricking and wounding that tender Organ.

(*q*) The Ancient Naturaliſts do generally agree, that *Miſſeltoe* is propagated by its Seeds carried about by, and paſſing through the Body of Birds. Thus *Theophraſtus de Cauſ. Plant. l.* 2. *c.* 24. Τὸ δ' ἀπὸ σῦς ὀρνίθων, &c. *Initium verò à paſtu avium:*—*Quippe Viſco detracto confectoque in alveis, quod frigidiſſimum eſt, ſemen cum excremento purum dimittitur, & factâ mutatione aliquâ in arbore Stercoris causâ pullulat, erumpitque, &c.* So alſo *Pliny* ſaith, viz. *Omnino autem ſatum* [Viſcum] *nullo modo naſcitur, nec niſi per alvum Avium redditum, maximè Palumbis ac Turdis. Hæc eſt natura, ut niſi maturatum in ventre Avium, non* prove-

many of them by their Uſefulneſs in Human Life, invite the Husbandman and Gardiner carefully to ſow and nurſe them up. To

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proveniat. Plin. N. H. l. 16. c. 44. Whether what *Theophraſtus* and *Pliny* affirm, be conducive to the better fertilizing the Seeds of *Miſſeltoe*, I know not; but that it is not of abſolute Neceſſity, I can affirm upon mine own Experience, having ſeen the Seeds germinate, even in the Bark of Oak. But although they ſhot above an Inch, and ſeem'd to root in the Tree, yet they came to nothing, whether deſtroy'd by Ants, *&c.* which I ſuſpected, or whether diſagreeing with the Oak, I know not. But I ſince find the Matter put out of doubt by Mr. *Doody*; which ſee in Mr. *Ray*'s *Hiſt. Plant. App. p.* 1918.

Nutmegs are ſaid to be fertiliz'd after the ſame Manner, as *Tavernier* ſaith was confirm'd to him by Perſons that lived many Years in thoſe Parts; whoſe Relation was: The *Nutmeg* being ripe, ſeveral Birds come from the Iſlands toward the South, and devour it whole, but are forced to throw it up again, before it be digeſted: And that the *Nutmeg*, then beſmear'd with a viſcous Matter, falling to the Ground, takes Root, and produces a Tree, which would never thrive, was it planted. *Tavern. of the Commod. of the* G. Mogul. And Monſieur *Thevenot*, in his Travels to the *Indies*, gives this Account: The Tree is produc'd after this Manner; there is a Kind of Birds in the Iſland, that having pick'd off the green Huſk, ſwallow the Nuts, which having been ſome Time in their Stomach, they void by the ordinary Way; and they fail not to take rooting in the Place where they fall, and in Time grow up to a Tree. This Bird is ſhap'd like a *Cuckow*; and the *Dutch* prohibit their Subjects, under Pain of Death, to kill any of them. *Vide* Sir *T. Pope-Blunt*'s *Nat. Hiſt.*

But Mr. *Ray* gives a ſomewhat different Account: *Hunc fructum* [Nucem Moſchatam] *variæ quidem aves depaſcuntur, ſed maximè Columbæ genus album & parvum, quæ dehiſcente nucamento, illectæ ſuavitate Macis, hunc cum Nuce eripiunt & devorant, nec niſi repletâ ingluvie capaciſſimâ ſaginam deſerunt. Noſtrates ibi mercatores Columbis iſtis* Nut-eaters *ſive Nucivoris nomen impoſuerunt. Quas autem vorant Nuces, poſt integras per alvum reddunt. Redditæ citiùs deinde germinant utpote præmaceratæ fervore Ventriculi. Arbores inde natæ ceu præcociores, facilè ſunt corruptioni obnoxiæ fructumque ferunt cæteris multo viliorem, & hac cauſa neglectum incolis contemtumque, præter Macin, quem ad adulterandum meliorem adhibent.* Ray H. P. l. 27. c. 4.

To this ſo ſingular a Care about the Propagation and Conſervation of the Species of Vegetables, I might add the nice Proviſion that is made for their Support and Aid, in ſtanding and growing, that they may keep their Heads above Ground, and not be rotted and ſpoil'd in the Earth themſelves, nor thereby annoy us; but on the contrary, miniſter to all their Ends, and our Uſes; to afford us Houſes, Utenſils, Food (*r*), Phyſick, Cloathing, yea, Diverſion too, by the Beauty of their Looks, by the Fragrancy of their Smell, by creating us pleaſant Shades againſt the ſcorching Beams of Summer, and skreening us againſt the piercing Winds, and Cold of Winter (*s*). And

(*r*) *Arbores blandioribus fruge ſuccis hominem mitigavere. Ex iis recreans membra Olei liquor, viresque potus Vini; tot denique ſapores annui ſponte venientes: & menſæ depugnetur licet earum cauſa cum feris, & paſti naufragorum corporibus piſces expetantur, etiamnum tamen ſecundæ: Mille præterea ſunt uſus earum, ſine quibus vita degi non poſſit. Arbore ſulcamus maria, terraſque admovemus, arbore exædificamus tecta.* Plin. N. H. l. 12. c. 1.

(*s*) *Plantarum Uſus latiſſimè patet, & in omni vitæ parte occurrit. Sine illis lautè, ſine illis commodè non vivitur, at nec vivitur omnino: Quæcunque ad victum neceſſaria ſunt, quæcunque ad delicias faciunt, è locupletiſſimo ſuo penu abundè ſubminiſtrant. Quanto ex iis menſa innocentior, mundior, ſalubrior quàm ex Animalium cæde & lanienâ? Homo certe naturâ Animal carnivorum non eſt; nullis ad prædam & rapinam armis inſtructum, non dentibus exertis & ſerratis, non unguibus aduncis. Manus ad fructus colligendos, dentes ad mandendos comparati. Non legimus ei ante Diluvium carnes ad eſum conceſſas. At non victum tantùm nobis ſuppeditant, ſed & Veſtitum, & Medicinam & Domicilia aliaque ædificia, & Navigia, & Supellectilem, & Focum, & Oblectamenta Senſuum Animique: Ex his naribus odoramenta & ſuffumigia parantur. Horum flores inenarrabili colorum & Schematum varietate, & elegantiâ, oculos exhilarant, ſuaviſſima odorum quos expirant fragantia ſpiritus recreant. Horum fructus gulæ illecebræ menſas ſecundas inſtruunt, & languentem appetitum excitant. Taceo virorem amœniſſimum oculis amicum, quem per prata paſcua agros, ſylvas ſpatiantibus objiciunt, & umbras quas contra æſtum & ſolis ardores præbent.* Ray ib. l. 1. c. 24. p. 46.

(*t*) All

And is is very obſervable what admirable Proviſions are made for this Purpoſe of their Support and Standing, both in ſuch as ſtand by their own Strength, and ſuch as need the Help of others. In ſuch as ſtand by their own Strength, it is by Means of the ſtronger and more ligneous Parts, (equivalent to the Bones in Animals,) being made not inflexible, as Bones; becauſe they would then be apt to break; but of a yielding elaſtick Nature, to eſcape and dodge the Violence of the Winds; and by Means alſo of the Branches ſpreading handſomely and commodiouſly about, at an Angle of about 45 *gr.* by which Means they equally fill up, and at the ſame Time make an Æquilibration of the Top (*t*).

And as for ſuch Vegetables as are weak, and not able to ſupport themſelves, 'tis a wonderful Faculty they have, ſo readily and naturally to make Uſe of the Help of their Neighbours, embracing and

(*t*) All Vegetables of a tall and ſpreading Growth, ſeem to have a natural Tendency to an hemiſpherical Dilation, but generally confine their Spreading within an Angle of 90 *gr.* as being the moſt becoming and uſeful Diſpoſition of its Parts and Branches. Now the ſhorteſt Way to give a moſt graceful and uſeful filling to that Space of dilating and ſpreading out, is to proceed in ſtrait Lines, and to diſpoſe of thoſe Lines, in a Variety of Parallels, &c. And to do that in a quadrantal Space, &c. there appears but one Way poſſible, and that is, to form all the Interſections, which the Shoots and Branches make, with Angles of 45 *gr.* only. And I dare appeal to all, if it be not in this Manner, almoſt to a Nicety obſerv'd by Nature, &c. A viſible Argument that the plaſtick Capacities of Matter are govern'd and diſpos'd by an All-wiſe and Infinite Agent, the native Strictneſſes and Regularities of them, plainly ſhewing from whoſe Hand they come. *Account of the Origine and Format. of Foſſ. Shells*, &c. *Print.* Lond. 1705. p. 38, 41.

and climbing up upon them (*u*), and uſing them as Crutches to their feeble Bodies: Some by their odd convolving Faculty, by twiſting themſelves like a Screw about others; ſome advancing themſelves, by catching and holding with their curious *Claſpers* and *Tendrels*, equivalent to the Hands; ſome by ſtriking in their rooty Feet; and others by the Emiſſion of a natural Glue, cloſely and firmly adhering to ſomething or other that adminiſters ſufficient Support unto them. All which various Methods being ſo nicely accommodated to the Indigencies

(*u*) *In Hederâ, ſurculi & rami hinc inde claviculos, quaſi radiculas emittunt, quæ parietibus, vel occurrentibus arboribus veluti digitis firmantur, & in altum ſuſpenduntur. Hujuſmodi radiculæ ſubrotundæ ſunt, & pilis coperiuntur; & quod mirum eſt, glutinoſum fundunt humorem, ſeu Terebinthinam, quâ arctè lapidibus nectuntur & agglutinantur. ——Non minori induſtriâ Natura utitur in Vite Canadenſi, &c.* The admirable and curious Make of whoſe Tendrels and their Feet, ſee in the illuſtrious Author, *Malpig. de Capreolis, &c. p.* 48.

Claſpers are of a Compound Nature, between that of a Root and a Trunk. Their Uſe is ſometimes for Support only; as in the Claſpers of Vines, Briony, &c. whoſe Branches being long, ſlender and fragile, would fall by their own Weight, and that of their Fruit; but theſe Claſpers taking hold of any Thing that is at Hand; Which they do by a natural Circumvolution which they have; (thoſe of Briony have a retrograde Motion about every third Circle, in the Form of a double Claſp; ſo that if they miſs one Way, they may catch the other.) Sometimes the Uſe of Claſpers is alſo for a Supply, as in the Trunk-Roots of Ivy; which being a Plant that mounts very high, and being of a cloſer and more compact Subſtance than that of Vines, the Sap would not be ſufficiently ſupply'd to the upper Sprouts, unleſs theſe aſſiſted the Mother-Root; but theſe ſerve alſo for Support too. Sometimes alſo they ſerve for Stabiliment, Propagation and Shade; for the firſt of theſe ſerve the Claſpers of Cucumers; for the ſecond, thoſe, or rather the Trunk-Roots of *Chamomil*; and for all Three the Trunk-Roots of *Strawberries*. *Harris Lex. Tech. in verb. Claſpers.*

(*w*) Vege-

digencies of thoſe helpleſs Vegetables, and not to be met with in any beſides, is a manifeſt Indication of their being the Contrivance and Work of the Creator, and that his Infinite Wiſdom and Care condeſcends, even to the Service, and Well-being of the meaneſt, moſt weak, and helpleſs inſenſitive Parts of the Creation.

In the laſt Place, to the Uſes already hinted at, I might add a large Catalogue of ſuch among Vegetables, as are of peculiar Uſe and Service to the World, and ſeem to be deſign'd as 'twere on Purpoſe, by the moſt Merciful Creator, for the Good of Man, or other Creatures (*w*). Among *Grain*, I might name the great Fertility (*x*) of ſuch as ſerves for Bread, the eaſy Culture and Propagation thereof, and the Agreement of every Soil and Climate to it. Among Trees, and Plants, I might inſtance in ſome that ſeem to be deſign'd, as 'twere, on Purpoſe, for almoſt every Uſe (*y*), and

(*w*) Vegetables afford not only Food to Irrationals, but alſo Phyſick, if it be true which *Ariſtotle* ſaith, and after him *Pliny*; which latter in his 8th *Book*, *Chap.* 27. ſpecifies divers Plants made uſe of as Specificks, by divers, both Beaſts and Birds: As *Dittany* by wounded *Deer*; *Celandine* by *Swallows*, to cure the ſore Eyes of their Young, &c. And if the Reader hath a mind to ſee more Inſtances of this Nature, (many of them fanciful enough,) he may conſult *Merſenne in Geneſ.* *p.* 933.

(*x*) See before, *Book* IV. *Chap.* 11. *Note* (*b*).

(*y*) *Planta hæc unica* [Aloe Americana] *inquit Fr. Hernandez, quicquid vitæ eſſe poteſt neceſſarium præſtare facilè poteſt, ſi eſſet rebus humanis modus. Tota enim illa lignorum ſepiendorumque agrorum uſum præſtat, caules tignorum, folia verò tecta tegendi imbricum, lancium: eorundem nervuli, & fibræ eundem habent uſum ad linteamina, calceos, & veſtimenta conficienda quem apud nos Linum, Cannabis, Goſſipium, &c. E mucronibus fiunt clavi, aculei, ſubulæ, quibus perforandis auribus, macerandi corporis gratiâ, Indis uti mos erat*

and Convenience; ſome to heal the moſt ſtubborn and dangerous Diſtempers (*z*), to alleviate and eaſe the Pains (*aa*) of our poor infirm Bodies, all the World

erat cùm Dæmonum vacarent cultui; item aciculæ, acus, tribuli militares & raſtillæ idoneæ pectendis ſubtegminibus. Præterea è ſucco mananti, cujus evulſis germinibus internis foliiſve tenerioribus cultis [Yztlinis] *in mediam cavitatem, ſtillat planta, unica ad 50 interdum amphoras (quod dictu eſt mirabile) Vina, Mel, Acetum ac Saccharum parantur* [The Methods of which he tells.] *Idem ſuccus menſes ciet, alvum lenit, Urinam evocat, Renes & Veſicam emundat. E radice quoque Reſtes fiunt firmiſſimæ. Craſſiores foliorum partes, truncuſque, decocta ſub terrâ, edendo ſunt aptæ, ſapiuntque Citrea fruſta ſaccharo condita: quin & vulnera recentia mirè conglutinant.——Folia quoque aſſa & affecto loco impoſita convulſionem curant, ac dolores leniunt (præcipue ſi ſuccus ipſe calens bibatur) quamvis ab Indicâ proficiſcantur lue, ſenſum hebetant, atque torporem inducunt. Radicis ſuccus luem Veneream curat apud Indos ut Dr.* Palmer. Ray. ibid. l. 21. c. 7. See alſo Dr. *Sloane's* Voyage to *Jamaica*, p. 247.

There alſo two Sorts of *Aloe* beſides, mentioned by the ſame Dr. *Sloane*, one of which is made uſe of for Fiſhing-Lines, Bow-Strings, Stockings, and Hammocks. Another hath Leaves that hold Rain-water, to which Travellers, &c. reſort to quench their Thirſt, in Scarcity of Wells, or Waters, in thoſe dry Countries. *Ibid. p.* 249.

(*z*) For Inſtance here, I ſhall name the *Cortex Peruvianus*, which Dr. *Morton* calls *Antidotus in levamen ærumnarum vitæ humanæ plurimarum divinitus conceſſa.* De Febr. Exer. v. c. 3. *In Sanitatem Gentium proculdubio à Deo O. M. conditus. Cujus gratiâ, Arbor vitæ, ſiqua alia, jure meritò appellari poteſt.* Id. ib. c. 7. *Eheu! quot convitiis Herculea & divina hæc Antidotus jactabatur?* Ibid.

To this (if we may believe the *Ephemer. German. Ann.* 12. *Obſer.* 74. and ſome other Authors) we may add *Trifolium Paludoſum*, which is become the *Panacea* of the *German* and Northern Nations.

(*aa*) *Pro doloribus quibuſcunque ſedandis præſtantiſſimi ſemper uſûs Opium habetur; quamobrem meritò* Nepenthe *appellari ſolet, & remedium verè divinum exiſtit. Et quidem ſatis mirari vix poſſumus, quomodo urgente viſceris aut membri cujuſpiam torturâ inſigni, & intolerabili cruciatu, pharmacum hoc, incantamenti inſtar, levamen & ἀναλγησίαν ſubitam, imò interdum abſque ſomno, aut ſaltem priùs quam advenerit, concedit. Porrò adhuc magis ſtupendum eſt, quod donec particulæ Opiatica operari, & potentiam ſuam narcoti-*

cam

World over: And some designed for the peculiar Service and Good of particular Places, either to cure such Distempers as are peculiar to them, by growing more plentifully there than elsewhere (*bb*); or else to obviate some Inconvenience there, or to supply some constant Necessity, or Occasion, not possible, or at least not easy, to be supplied any other Way (*cc*). It is, for Instance, an admirable

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cam exerere continuant, imò etiam aliquamdiu postquam somnus finitur, summa aleviatio, & indolentia in parte affectâ persisti. Willis, Phar. rat. Par. 1. S. 7. cap. 1. sect. 15.

(*bb*) *Tales Plantarum species in quacunque regione à Deo creantur quales hominibus & animalibus ibidem natis maximè conveniunt; imò ex plantarum nascentium frequentiâ se fere animadvertere posse quibus morbis* [endemiis] *quælibet regio subjecta sit, scribit Solenander. Sic apud Danos, Frisios, Hollandos, quibus, Scorbutus frequens, Cochlearia copiosè provenit.* Ray. H. Pl. lib. 16. cap. 3.

To this may be added, *Elsner*'s Observations concerning the Virtues of divers Things in his Observations *de Vincetoxico Scrophularum remedio.* F. Germ. T. 1. Obs. 57.

John Benorovinus, a Physician of *Dort*, may be here consulted, who wrote a Book on Purpose to shew, That every Country hath every Thing serving to its Occasions, and particular Remedies afforded to all the Distempers it is subject unto. See *Bener.* Αὐταρκεια. *Batav. sive Introd. ad Medic. indigenam.*

(*cc*) The Description Dr. *Sloane* gives of the *Wild-Pine* is, That its Leaves are chanelled, fit to catch and convey Water down into their Reservatories; that these Reservatories are so made, as to hold much Water, and close at Top when full, to hinder its Evaporation; that these Plants grow on the Arms of the Trees in the Woods every where [in those Parts] as also on the Barks of their Trunks. And one Contrivance of Nature in this Vegetable, (he saith,) is very admirable. The Seed hath long and many Threads of *Tomentum*, not only that it may be carried every where by the Wind——but also, that it may by those Threads, when driven through the Boughs, be held fast, and stick to the Arms, and extant Parts of the Barks of Trees. So soon as it Sprouts or Germinates, although it be on the under Part of a Bough, ——its Leaves and Stalk rise perpendicular, or strait up, because

ble Provision made for some Countries subject to Drought, that when the Waters every where fail, there are Vegetables which contain not only Moisture enough to supply their own Vegetation and Wants, but afford Drink also both to Man and other Creatures, in their great Extremities (*dd*); and

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because if it had any other Position, the Cistern (before-mentioned, by which it is chiefly nourished——) made of the hollow Leaves, could not hold Water, which is necessary for the Nourishment and Life of the Plant.——In Scarcity of Water, this Reservatory is necessary and sufficient, not only for the Plant it self, but likewise is very useful to Men, Birds, and all Sorts of Insects, whither they come in Troops, and seldom go away without Refreshment. *Id. ib. p.* 188. and *Phil. Trans.* No. 251, where a Figure is of this notable Plant, as also in *Lowthorp's Abridg. Vol. 2. p.* 669.

The *Wild-Pine*, so called, &c. hath Leaves that will hold a Pint and a half, or Quart of Rain-Water; and this Water refreshes the Leaves, and nourishes the Root. When we find these Pines, we stick our Knives into the Leaves, just above the Root, and that lets out the Water, which we catch in our Hats, as I have done many Times to my great Relief. *Dampier's Voy. to Campeachy, c. 2. p.* 56.

(*dd*) *Navarette* tells us of a Tree called the *Bejuco*, which twines about other Trees, with its End hanging downwards; and that Travellers cut the Nib off it, and presently a Spout of Water runs out from it, as clear as Crystal, enough, and to spare, for six or eight Men. I drank, (saith he,) to my Satisfaction of it, found it cool and sweet, and would drink it as often as I found it in my Way. It is a Juice and natural Water. It is the common Relief of the Herdsmen on the Mountains; when they are Thirsty, they lay hold on the *Bejuco*, and drink their fill. *Collect. of Voy. and Trav. Vol.* 1. *in the Suppl. to* Navarette's *Account of* China, *p.* 355.

The *Waterwith* of *Jamaica* hath the same Uses, concerning which, my before-commended Friend, Dr. *Sloane*, favoured me with this Account from his Original Papers: *This Vine growing on dry Hills, in the Woods, where no Water is to be met with, its Trunk, if cut into Pieces two or three Yards long, and held by either End to the Mouth, affords so plentifully a limpid, innocent, and refreshing Water, or Sap, as gives new Life to the droughty Traveller or Hunter. Whence this is very much celebrated by all the Inhabitants*

of

and a great deal more might be instanced in of a like Nature, and Things that bear such plain Impresses of the Divine Wisdom and Care, that they manifest the Super-intendence of the Infinite Creator.

Thus I have given a Sketch of another Branch of the Creation, which (although one of the meanest, yet) if it was accurately viewed, would abundantly manifest it self to be the Work of GOD. But because I have been so long upon the other Parts, although less than they deserve, I must therefore content my self with those general Hints I have given; which may however serve as Specimens of what might have been more largely said about this inferiour Part of the animated Creation.

As to the *Inanimate Part*, such as Stones, Minerals, Earth, and such-like, that which I have already said in the Beginning shall suffice.

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of these Islands, as an immediate Gift of Providence to their distressed Condition.

To this we may add what Mr. *Ray* takes Notice of concerning the *Birch-Tree*. *In initiis Veris antequam folia prodiere, vulnerato dulcem succum copiosè effundit, quem siti pressi Pastores in sylvis sæpenumero potare solent. Nos etiam non semel eo liquore recreati sumus, cùm herbarum gratiâ vastas peragravimus sylvas, inquit Tragus.* Raii Cat. Plant. circa. Cantab. in Betula.

BOOK XI.

Practical Inferences from the foregoing SURVEY.

HAVING in the preceding BOOKS carried my Survey as far as I care at preſent to engage my ſelf, all that remaineth, is to draw ſome Inferences from the foregoing Scene of the Great Creator's Works, and ſo conclude this Part of my intended Work.

CHAP. I.

That God's Works are Great and Excellent.

THE firſt Inference I ſhall make, ſhall be by way of Confirmation of the Text, That *the Works of the Lord are great* (*a*). And this is neceſſary to be obſerved, not againſt the Atheiſt only, but all other careleſs, incurious Obſervers of God's

(*a*) *Equidem ne laudare quidem ſatis pro merito poſſum ejus Sapientiam ac Potentiam, qui animalia fabricatus eſt. Nam ejuſmodi opera non Laudibus modò, verùm etiam Hymnis ſunt majora, quæ priuſquam inſpexiſſemus, fieri non poſſe perſuaſum habeamus, conſpicati verò, falſos nos opinione fuiſſe comperimus.* Galen. de Uſ. Part. l. 7. c. 15.

(*b*) *Non*

God's Works. Many of our uſeful Labours, and ſome of our beſt modern Books ſhall be condemned with only this Note of Reproach, That they are about trivial Matters (*b*), when in Truth they are ingenious and noble Diſcoveries of the Works of GOD. And how often will many own the World in General to be a Manifeſtation of the Infinite Creator, but look upon the ſeveral Parts thereof as only Toys and Trifles, ſcarce deſerving their Regard? But in the foregoing (I may call it) tranſient View I have given of this lower, and moſt ſlighted Part of the Creation, I have, I hope, abundantly made out, that all the Works of the LORD, from the moſt regarded, admired, and praiſed, to the meaneſt and moſt ſlighted, are Great and Glorious Works, incomparably contrived, and as admirably made, fitted up, and placed in the World. So far then are any of the Works of the LORD, (even thoſe eſteemed the meaneſt) from deſerving to be diſregarded, or contemned by us (*c*), that on the contrary they deſerve (as ſhall be ſhewn in the next Chapter) to be *ſought out, enquired after*, and *curiouſly*, and *diligently pryed into* by us; as I have ſhewed the Word in the Text implies.

(*b*) *Non tamen pigere debet Lectores, ea intelligere, quemadmodum ne Naturam quidem piguit ea reipsâ efficere.* Galen. ibid. l. 11. fin.

(*c*) *An igitur etiamſi quemadmodum Natura hæc, & ejuſmodi, ſummâ ratione ac providentiâ agere potuit, ita & nos imitari aliquando poſſemus? Ego vero exiſtimo multis noſtrum ne id quidem poſſe, neque enim artem Naturæ exponunt: Eo enim modo omnino eam admirarentur, ſin minûs, eam ſaltem non vituperarent.* Galen. ibid. l. 10. c. 3.

CHAP.

CHAP. II.

That God's Works ought to be enquired into, and that ſuch Enquiries are commendable.

THE *Creator* doubtleſs did not beſtow ſo much Curioſity, and exquiſite Workmanſhip and Skill upon his Creatures, to be looked upon with a careleſs, incurious Eye, eſpecially to have them ſlighted or contemned; but to be admired by the rational Part of the World, to magnify his own Power, Wiſdom and Goodneſs throughout all the World, and the Ages thereof. And therefore we may look upon it as a great Error, not to anſwer thoſe Ends of the Infinite *Creator*, but rather to oppoſe and affront them. On the contrary, my Text commends GOD's Works, not only for being Great, but alſo approves of thoſe curious and ingenious Enquirers, that *ſeek them out*, or *pry into them*. And the more we pry into, and diſcover of them, the Greater and more Glorious we find them to be, the more worthy of, and the more expreſly to proclaim their Great *Creator*.

Commendable then are the Reſearches, which many amongſt us have, of late Years, made into the Works of Nature, more than hath been done in ſome Ages before. And therefore when we are asked, *Cui Bono?* To what Purpoſe ſuch Enquiries, ſuch Pains, ſuch Expence? The Anſwer is eaſy, It is to anſwer the Ends for which GOD beſtowed ſo much Art, Wiſdom and Power about them, as well

well as given us Senſes to view and ſurvey them; and an Underſtanding and Curioſity to ſearch into them: It is to follow and trace Him, when and whither He leads us, that we may ſee and admire His Handy-work our ſelves, and ſet it forth to others, that they may ſee, admire, and praiſe it alſo. I ſhall then conclude this Inference with what *Elihu* recommends, *Job* xxxvi. 24, 25. *Remember that thou magnify his Work, which Men behold. Every Man may ſee it, Men may behold it afar off.*

CHAP. III.

That God's Works are manifeſt to all: Whence the Unreaſonableneſs of Infidelity.

THE concluding Words of the preceding Chapter ſuggeſts a third Inference, that the Works of GOD are ſo viſible to all the World, and withal ſuch manifeſt Indications of the Being, and Attributes of the Infinite Creator, that they plainly argue the Vileneſs and Perverſeneſs of the Atheiſt, and leave him inexcuſable. For it is a Sign a Man is a wilful, perverſe Atheiſt, that will impute ſo Glorious a Work, as the Creation is, to any Thing, yea, a mere *Nothing* (as Chance is) rather than to GOD (*a*). It is a Sign the Man is wilfully blind, that

(*a*) *Galen* having taken Notice of the neat Diſtribution of the Nerves to the Muſcles, and other Parts of the Face, cries out, *Hæc enim fortunæ ſunt opera! Cæterùm tum omnibus* [partibus] *immitti, tantoſque eſſe ſingulos* [*nervos*] *magnitudine, quanta particulæ erat neceſſe; haud ſcio an hominum ſit ſobriorum ad Fortunam opificem*

that he is under the Power of the Devil, under the Government of Prejudice, Luſt, and Paſſion, not right Reaſon, that will not diſcern what *every one can ſee, what every Man may behold afar off*, even the Exiſtence and Attributes of the CREATOR from his Works. For as *there is no Speech or Language where their Voice is not heard, their Line is gone out through all the Earth, and their Words to the End of the World*: So all, even the barbarous Nations, that never heard of GOD, have from theſe his Works inferred the Exiſtence of a Deity, and paid their Homages to ſome Deity, although they have been under great Miſtakes in their Notions and Concluſions about Him. But however, this ſhews how naturally and univerſally all Mankind agree, in deducing their Belief of a God from the Contemplation of his Works, or as even *Epicurus* himſelf, in *Tully* (*b*) ſaith, from a *Notion that Nature it ſelf hath imprinted upon the Minds of Men. For*, ſaith he, *what Nation is there, or what kind of Men, that*

id revocare. Alioqui quid tandem erit, quod cum Providentiâ & Arte efficitur? Omnino enim hoc ei contrarium eſſe debet, quod Caſu ac Fortuito fit. And afterwards, *Hæc quidem atque ejuſmodi Artis ſcil. ac Sapientiæ opera eſſe dicemus, ſi modo Fortunæ tribuenda ſunt quæ ſunt contraria; fietque jam quod in proverbiis——Fluvii ſurſum fluent; ſi opera quæ nullum habent neque ornamentum neque rationem, neque modum Artis eſſe; contraria vero Fortunæ duxerimus, &c.* Galen. ubi ſupra. l. 11. c. 7.

(*b*) *Primùm eſſe Deos, quod in omnium animis, &c.* And a little after, *Cùm enim non inſtituto aliquo, aut more, aut lege ſit opinio conſtituta, maneatque ad unum omnium firma conſenſio, intelligi neceſſe eſt, eſſe Deos, quoniam inſitas eorum vel potiùs innatas cognitiones habemus. De quo autem omnium Natura conſentit, id verum eſſe neceſſe eſt. Eſſe igitur Deos confitendum eſt.* Cicer. de Nat. Deor. l. 1. c. 16, 17.

(*c*) The

that without any Teaching or Inſtructions, have not a kind of Anticipation, or pre-conceived Notion of a Deity?

An Atheiſt therefore (if ever there was any ſuch) may juſtly be eſteemed a Monſter among Rational Beings; a Thing hard to be met with in the whole Tribe of Mankind; an Oppoſer of all the World (*c*); a Rebel againſt Human Nature and Reaſon, as well as againſt his GOD.

But above all, monſtrous is this, or would be, in ſuch as have heard of GOD, who have had the Benefit of the clear Goſpel-Revelation. And ſtill more monſtrous this would be, in one Born and Baptized in the Chriſtian Church, that hath ſtudied Nature, and hath pried farther than others into God's Works. For ſuch an one (if it be poſſible for ſuch to be) to deny the Exiſtence, or any of the Attributes of GOD, would be a great Argument of the Infinite Inconvenience of thoſe Sins of Intemperance, Luſt, and Riot, that have made the Man abandon his Reaſon, his Senſes, yea, I had almoſt ſaid his very Human Nature (*d*), to engage him thus to deny the Being of GOD.

So alſo it is much the ſame monſtrous Infidelity, at leaſt betrays the ſame Atheiſtical Mind, to deny GOD's Providence, Care and Government of the World, or (which is a Spawn of the ſame *Epicurean*

(*c*) The Atheiſt in denying a God, doth, as *Plutarch* ſaith, endeavour——*immobilia movere, & bellum inferre non tantùm longo tempori, ſed & multis hominibus, gentibus, & familiis, quas religioſus Deorum cultus, quaſi divino furore correptas, tenuit.* Plutar. de Iſide.

(*d*) See before, *Note* (*b*).

curean Principles) to deny *Final Cauſes* (*e*) in God's Works of Creation; or with the Profane, in *Pſal.* lxxiii. 11. to ſay, *How doth God know? And is there Knowledge in the moſt High?* For as the witty and eloquent *Salvian* ſaith (*f*), *They that affirm nothing is ſeen by GOD, will*, in all Probability, *take away the Subſtance, as well as Sight of God.*——*But what ſo great Madneſs*, ſaith he, *as that when a Man doth not deny GOD to be the Creator of all Things, he ſhould deny him to be the Governour of them? Or when he confeſſeth him to be the Maker, he ſhould ſay, GOD neglecteth what he hath ſo made?*

(*e*) *Galen* having ſubſtantially refuted the *Epicurean* Principles of *Aſclepiades*, by ſhewing his Ignorance in Anatomy and Philoſophy, and by demonſtrating all the *Cauſes* to be evidently in the Works of *Nature*, viz. *Final*, *Efficient*, *Inſtrumental*, *Material*, and *Formal Cauſes*, concludes thus againſt his fortuitous Atoms, *ex quibus intelligi poteſt: Conditorem noſtrum in formandis particulis unum hunc ſequi ſcopum, nempe ut quod melius eſt eligat.* Galen. de Uſ. Part. l. 6. c. 13.

(*f*) *De Gubern. Dei.* l. 4. p. 124. *meo Libro*; alſo *l.* 7. *c.* 14.

CHAP. IV.

That God's Works ought to excite us to Fear and Obedience to God.

SInce the Works of the Creation are all of them ſo many Demonſtrations of the Infinite Wiſdom and Power of God, they may ſerve to us as ſo many Arguments exciting us to the conſtant *Fear of God*, and to a ſteady, hearty *Obedience* to all his Laws. And thus we may make theſe Works as ſervice-

ſerviceable to our ſpiritual Intereſt, as they all are to our Life, and temporal Intereſt. For if whenever we ſee them, we would conſider that theſe are the Works of our Infinite *Lord* and *Maſter*, to whom we are to be accountable for all our Thoughts, Words and Works, and that in theſe we may ſee his Infinite Power and Wiſdom; this would check us in Sinning, and excite us to ſerve and pleaſe Him, who is above all Controul, and who hath our Life and whole Happineſs in his Power. After this Manner GOD himſelf argues with his own *fooliſh People, and without Underſtanding, who had Eyes, and ſaw not, and had Ears, and heard not,* Jer. v. 21, 22. *Fear ye not me? ſaith the Lord: will ye not tremble at my Preſence, which have placed the Sand for the Bound of the Sea, by a perpetual Decree, that it cannot paſs it; and though the Waves thereof toſs themſelves, yet can they not prevail; though they roar, yet can they not paſs over it?*

This was an Argument that the moſt ignorant, ſtupid Wretches could not but apprehend; that a Being that had ſo vaſt and unruly an Element, as the Sea, abſolutely at his Command, ought to be feared and obeyed; and that he ought to be conſidered as the Sovereign Lord of the World, on whom the World's Proſperity and Happineſs did wholly depend; *ver.* 24. *Neither ſay they in their Heart, let us now fear the Lord our God, that giveth Rain, both the former and the latter in his Seaſon: He reſerveth unto us the appointed Weeks of the Harveſt.*

CHAP. V.

That GOD's Works ought to excite us to Thankfulneſs.

AS the Demonſtrations which GOD hath given of his Infinite *Power* and *Wiſdom* ſhould excite us to Fear and Obedience; ſo I ſhall ſhew in this Chapter, that the Demonſtrations which he hath given of his Infinite *Goodneſs* in his Works, may excite us to due Thankfulneſs and Praiſe. It appears throughout the foregoing Survey, what Kindneſs GOD hath ſhewn to his Creatures in providing every Thing conducing to their Life, Proſperity and Happineſs (*a*); how they are all contrived and made in the beſt Manner, placed in the fitteſt Places of the World for their Habitation and Comfort; accoutred in the beſt Manner, and accommodated with every, even all the minuteſt Things that may miniſter to their Health, Happineſs,

(*a*) *Si pauca quis tibi donâſſet jugera, accepiſſe te diceres beneficium: immenſa terrarum latè patentium ſpatia negas eſſe beneficium? Si pecuniam tibi aliquis donaverit——beneficium vocabis: tot metalla defodit, tot flumina emiſit in æra, ſuper quæ decurrunt ſola aurum vehentia: argenti, æris, ferri immane pondus omnibus locis obrutum, cujus inveſtigandi tibi facultatem dedit,——negas te accepiſſe beneficium? Si domus tibi donetur, in quâ marmoris aliquid reſplendeat, &c. Num mediocre munus vocabis? Ingens tibi domicilium, ſine ullo incendii, aut ruinæ metu ſtruxit, in quo vides non tenues cruſtas——ſed integras lapidis pretioſiſſimi moles, &c. negas te ullum munus accepiſſe? Et cùm iſta quæ habes magno æſtimes, quod eſt ingrati hominis, nulli debere te judicas? Unde tibi iſtum quem trahis ſpiritum? Unde iſtam, per quam ductus vitæ tuæ diſponis atque ordinas, lucem? &c.* Senec. de Benef. l. 4. c. 6.

(*b*) *Tem-*

neſs, Office, Occaſions, and Buſineſs in the World.

Upon which Account, Thankfulneſs and Praiſe is ſo reaſonable, ſo juſt a Debt to the *Creator*, that the *Pſalmiſt* calleth upon all the Creatures to praiſe God, in *Pſalm* cxlviii. *Praiſe him all his Angels, Praiſe him all his Hoſts; Sun, Moon, Stars of Light, Heavens of Heavens, and Waters above the Heavens.* The Reaſon given for which is, *ver.* 5, 6. *For he commanded, and they were created; he hath alſo eſtabliſhed them for ever and ever; he hath made a Decree which they ſhall not paſs.* And not theſe Celeſtials alone, but the Creatures of the Earth and Waters too, even the Meteors, *Fire and Hail, Snow and Vapours, ſtormy Winds fulfilling his Word.* Yea, the very *Mountains and Hills, Trees, Beaſts, and all Cattle, creeping Things, and flying Fowl.* But in a particular Manner, all the Ranks and Orders, all the Ages and Sexes of Mankind are charged with this Duty; *Let them praiſe the Name of the Lord, for his Name alone is excellent; his Glory is above the Earth and Heavens*, ver. 13.

And great Reaſon there is we ſhould be excited to true and unfeigned Thankfulneſs and Praiſe (*b*) to

(*b*) *Tempeſtivum tibi jam fuerit, qui in hiſce libris verſaris conſiderare, in utram Familiam recipi malis*, Platonicamne *ac* Hippocraticam, *& aliorum virorum, qui Naturæ opera mirantur; an eorum qui ea inſectantur, quod non per Pedes natura conſtituit effluere Excrementa.* Of which having told a Story of an Acquaintance of his that blamed Nature on this Account, he then goes on, *At verò ſi de hujuſmodi pecudibus plura verba fecero, melioris mentis homines meritò mihi forte ſuccenſeant, dicantque me polluere ſacrum ſermonem, quem ego* CONDITORIS *noſtri verum Hymnum compono, exiſtimoque in eo veram eſſe pietatem,——ut ſi noverim ipſe primus,*

to this our Great Benefactor, if we reflect upon what hath been ſhewn in the preceding Survey, that the *Creator* hath done for Man alone, without any Regard to the reſt of the Creatures, which ſome have held were made for the Sake of Man. Let us but reflect upon the Excellence and Immortality of our Soul; the incomparable Contrivance, and curious Structure of our Body; and the Care and Caution taken for the Security and Happineſs of our State, and we ſhall find, that among the whole Race of Beings, Man hath eſpecial Reaſon to magnify the Creator's Goodneſs, and with ſuitable ardent Affections to be thankful unto him.

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primus, deinde & aliis expoſuerim, quænam ſit ipſius Sapientia, quæ Virtus, quæ Bonitas. Quod enim cultu conveniente exornaverit omnia, nullique bona inviderit, id perfectiſſimæ Bonitatis ſpecimen eſſe ſtatuo; & hac quidem ratione ejus Bonitas Hymnis nobis eſt celebranda. Hoc autem omne inveniſſe quo pacto omnia potiſſimùm adornarentur, ſummæ Sapientiæ eſt: effeciſſe autem omnia, quæ voluit, Virtutis eſt invictæ. Galen. de Uſ. Part. l. 3. c. 10.

CHAP. VI.

That we ought to pay God all due Homage, and Worſhip, particularly that of the Lord's Day.

FOR a Concluſion of theſe Lectures, the laſt Thing I ſhall infer, from the foregoing Demonſtration of the Being and Attributes of GOD, ſhall be, that we ought to pay GOD all that *Homage* and *Worſhip* which his Right of Creation and Dominion entitle him unto, and his Great Mercies call for from us. And foraſmuch as the *Creator* appointed, from the very Creation, one Day in ſeven

ſeven to his Service, it will not therefore be improper to ſay ſomething upon that Subject: And if I inſiſt ſomewhat particularly and largely thereon, the Congruity thereof to the Deſign of theſe Lectures, and the foregoing Demonſtration, together with the too great Inadvertency about, and Neglect of this Ancient, Univerſal, and moſt Reaſonable and Neceſſary Duty, will, I hope, plead my Excuſe. But that I may ſay no more than is neceſſary on this Point, I ſhall confine my ſelf to two Things; the *Time* God hath taken, and the *Buſineſs* then to be performed.

I. The *Time* is one Day in ſeven, and one of the Ancienteſt Appointments it is which GOD gave to the World. For as ſoon as GOD had finiſhed his ſix Days Works of Creation, it is ſaid, *Gen.* ii. 2, 3. *He reſted on the ſeventh Day from all his Work which he had made. And GOD bleſſed the ſeventh Day, and ſanctified it, becauſe that in it he had reſted from all his Work.* This Sanctification (*a*), and Bleſſing the Seventh Day, was ſetting it apart, as a Day of Diſtinction from the reſt of the Week-Days, and appropriating it to Holy Uſes and Purpoſes, namely, the Commemoration of that Great Work of the Creation, and paying Homage and Worſhip to that Infinite Being, who was the Effector of it.

This Day, thus conſecrated from the Beginning, for the Celebration of the τῦ κόσμυ γενέσιον the *World's Birth-Day*, as *Philo* calls it, was pro-

(*a*) קדש *Uſibus divinis accommodavit, à communi & profano uſu ſegregavit, in uſum ſacrum ad cultum Dei deſtinavit.* Kirch. Concord. p. 1336. *Deſtinari ad aliquid, Sacrari,* &c. Buxtorf. in Verbo.

bably

bably in ſome Meaſure forgotten in the following wicked Ages, which God complains of, *Gen.* vi. 5. and ſo after the Flood likewiſe. But after the Return out of *Ægypt*, when GOD ſettled the *Jewiſh* Polity, he was pleaſed to renew this Day, and to eſtabliſh it for a perpetual ſtanding Law. And accordingly it was obſerved down to our Bleſſed Saviour's Time, countenanced, and ſtrictly obſerved by our Great LORD and Maſter himſelf, and his Apoſtles and Diſciples in, and after his Time; and although for good Reaſons the Day was changed by them, yet a Seventh Day hath been conſtantly obſerved in all Ages of Chriſtianity, down to our preſent Time.

Thus we have a Day appointed by GOD himſelf, and obſerved throughout all Ages, except ſome few perhaps, which deſerve not to be brought into Example.

And a wiſe Deſignation of Time this is, well becoming the Divine Care and Precaution; ſerving for the recruiting our Bodies, and diſpatching our Affairs, and at the ſame Time to keep up a Spiritual Temper of Mind. For by allowing ſix Days to Labour, the Poor hath Time to earn his Bread, the Man of Buſineſs Time to diſpatch his Affairs, and every Man Time for the Work of his reſpective Calling. But had there been more, or all our Time allotted to Labour and Buſineſs, and none to reſt and recruit, our Bodies and Spirits would have been too much fatigued and waſted, and our Minds have been too long engaged about worldly Matters, ſo as to have forgotten Divine Things. But the Infinitely Wiſe Ruler of the World, having taken the Seventh Part of our Time to his own Service, hath pre-

prevented these Inconveniencies; hath given a Relaxation to our selves; and Ease and Refreshment to our wearied Beasts, to poor fatigued Slaves, and such as are under the Bondage of Avaritious, Cruel Masters. And this is one Reason *Moses* gives of the Reservation and Rest on the Seventh Day, *Deut.* v. 13, 14, 15. *Six Days shalt thou labour, and do all thy Work; but the Seventh is the Sabbath of the* LORD *thy* GOD; *in it thou shalt not do any Work, thou,* nor thy Children, Servants, Cattel, or Stranger, *that thy Man-Servant and Maid-Servant may rest as well as thou. And remember, that thou wast a Servant,* &c. *therefore the* LORD *thy* GOD *commanded thee to keep the Sabbath Day.* That carnal, greedy People, so bent upon Gain, without such a Precept, would have scarce favoured their own Bodies, much less have had Mercy upon their poor Bondsmen and Beasts; but by this Wise Provision, this great Burden was taken off. But on the other Hand, as a longer Liberty would too much have robbed the Master's Time, and bred Idleness, so by this Wise Provision, of only one Day of Rest, to six of Labour, that Inconvenience was also prevented.

Thus the Wise Governour of the World, hath taken Care for the Dispatch of Business. But then as too long Engagement about worldly Matters, would take off Mens Minds from God and Divine Matters; so by this Reservation of every Seventh Day, that great Inconvenience is prevented also; all being then bound to Worship their Great Lord and Master, to pay their Homages, and Acknowledgments to their infinitely kind Benefactor; and in a

Word,

Word, to exerciſe themſelves in Divine, Religious Buſineſs, and ſo keep up that ſpiritual Temper of Mind, that a perpetual, or too long Application to the World would deſtroy.

This, as it was a good Reaſon for the Order of a Sabbath to the *Jews*; ſo is as good a Reaſon for our Saviour's Continuance of the like Time in the Chriſtian Church.

And a Law this is, become the Infinitely Wiſe Creator and Conſervator of the World; a Law, not only of great Uſe to the Perpetuating the Remembrance of thoſe greateſt of God's Mercies then commemorated, but alſo exactly adapted to the Life, Occaſions, and State of Man; of Man living in this, and a-kin to another World: A Law well calculated to the Diſpatch of our Affairs, without hurting our Bodies or Minds. And ſince the Law is ſo wiſe and good, we have great Reaſon then to practiſe carefully the Duties incumbent upon us; which will fall under the Conſideration of the

II. Thing I propoſed, the *Buſineſs* of the Day, which God hath reſerved to himſelf. And there are two Things enjoyned in the Commandment, a *Ceſſation* from Labour and worldly Buſineſs; and that we *remember to keep* the Day Holy.

1. There muſt be a Ceſſation from worldly Buſineſs, or a Reſt from Labour, as the Word *Sabbath* (*b*) ſignifies. *Six Days thou ſhalt do all thy Work, but the Seventh is the Sabbath of the Lord thy GOD* [not thy Day but his] *in which neither thou, nor any belonging to thee, ſhall do any Work.* In which Injunction it is obſervable,

(*b*) שבת *Ceſſatio, Requies.*

how

how expreſs and particular this Commandment is, more than others, in ordering all Sorts of Perſons to ceaſe from Work.

2. We muſt *remember to keep the Day Holy.* Which *Remembrance* is another Thing alſo in this, more than in the other Commandments, and implies,

1*ſt*, That there is great Danger of our forgetting, neglecting, or being hindred from keeping the Day Holy, either by the Infirmity and Carnality of our own Nature, or from the Avocations of the World.

2*dly*, That the keeping it Holy, is a Duty of more than ordinary Conſequence and Neceſſity. And of greateſt Conſequence this is,

Firſt, To perpetuate the Remembrance of thoſe grand Works of GOD commemorated on that Day; in the firſt Ages of the World, the Creation; in the middle Ages, the Creation and Delivery from *Ægypt*; and under Chriſtianity, the Creation and Redemption by Chriſt. Which Mercies, without ſuch frequent Occaſions, would be ready to be forgotten, or diſregarded, in ſo long a Tract of Time, as the World hath already ſtood, and may, by God's Mercy ſtill ſtand.

Secondly, To keep up a Spiritual Temper of Mind, by thoſe frequent weekly Exerciſes of Religion, as hath been already mention'd.

Thirdly, To procure GOD's Bleſſing upon the Labours and Buſineſs of our ſix Days, which we can never expect ſhould be proſperous, if we are negligent of GOD's Time. For how can we expect GOD's Bleſſing upon a Week ſo ill begun, with a Neglect, or Abuſe of GOD's firſt Day? And there-

therefore if we become unproſperous in the World; if Loſſes, Troubles, or Dangers befall us, let us reflect how we have ſpent the *Lord*'s Day; whether we have not wholly neglected it, or abuſed it in Riot, or made it a Day for taking Journeys, for more private Buſineſs, and leſs ſcandalous Labour, as the Cuſtom of too many is.

Thus having ſhewn what Reaſon there is to *remember* to keep Holy the Day dedicated to GOD, I ſhall conſider how we are to keep it Holy, and ſo conclude. Now the Way to keep it Holy, is not by bare reſting from Work; for that, as a Father ſaith, is *Sabbatum Boum & Aſinorum*, a *Sabbath of Beaſts*: But Holy Acts are the proper Buſineſs for an Holy Day, celebrated by Rational Beings. Among all which, the grand, principal, and moſt univerſally practis'd, is the *Publick Worſhip of GOD*, the aſſembling at the *Publick Place* of his *Worſhip*, to pay (with our Fellow-Creatures) our Homages, Thanks, and Praiſes to the Infinite *Creator* and *Redeemer* of the World. This as it is the moſt reaſonable Service, and proper Buſineſs for this Day, ſo is what hath been the Practice of all Ages. It was as early as *Cain* and *Abel*'s Days, *Gen.* iv. 3. what was practis'd by Religious Perſons in the following Ages, till the giving of the Law; and at the giving of That, God was pleas'd to order Places, and his particular Worſhip, as well as the Seventh Day. The Tabernacle and Temple were appointed by God's expreſs Command; beſides which, there were Synagogues all over the Nation; ſo that in our Saviour's Time, every great Town,

Town, or Village, had one, or more in it, and *Jeruſalem* 460, or more (*c*).

The Worſhip of theſe Places, our Bleſſed SAVIOUR was a conſtant and diligent Frequenter of. It is ſaid, *He went about all the Cities and Villages, Teaching in their Synagogues, and Preaching, and Healing*, &c. *Mat.* ix. 35. And St. *Luke* reporteth it as his conſtant Cuſtom or Practice, *Luke* iv. 16. *And as his Cuſtom was, he went into the Synagogue on the Sabbath-Day.*

Having thus mention'd the Practice of Christ, it is not neceſſary I ſhould ſay much of the Practice of his *Apoſtles*, and the following purer Ages of Chriſtianity, who, in ſhort, as their Duty was, diligently follow'd their Great Maſter's Example. *They did not think it enough to read and pray, and praiſe God at Home, but made Conſcience of appearing in the Publick Aſſemblies, from which nothing but Sickneſs and abſolute Neceſſity did detain them; and if Sick, or in Priſon, or under Baniſhment, nothing troubled them more, than that they could not come to Church, and join their Devotions to the Common Services. If Perſecution at any Time forc'd them to keep a little Cloſe; yet no ſooner was there the leaſt Mitigation, but they preſently returned to their open Duty, and publickly met all together. No trivial Pretences, no light Excuſes were then admitted for any ones Abſence from the Congregation, but according to the Merit of the Cauſe, ſevere Cenſures were paſs'd*

(*c*) See *Lightfoot*'s Works, Vol. 2. p. 35, *and* 646.

upon

upon them, &c. to expreſs it in the Words of one of our beſt Antiquaries (*d*).

The *Publick Worſhip* of GOD then, is not a Matter of Indifference, which Men have in their own Power to do, or omit as they pleaſe; neither is it enough to read, pray, or praiſe God at Home, (unleſs ſome inevitable Neceſſity hindereth;) becauſe the appearing in GOD's Houſe, on *his* Day, is an Act of *Homage* and *Fealty*, due to the Creator, a *Right of Sovereignty* we pay him. And the with-holding thoſe Rights and Dues from GOD, is a kind of rejecting GOD, a diſowning his Sovereignty, and a with-drawing our Obedience and Service. And this was the very Reaſon why the Profanation of the Sabbath was puniſh'd with Death among the *Jews*, the Sabbath being a Sign, or Badge of the GOD they own'd and worſhipp'd (*e*). Thus *Exod.* xxxi. 13. *My Sabbath*

(*d*) Dr. *Cave*'s *Primitive Chriſtianity*, Par. 1. cap. 7.

(*e*) At this Day it is cuſtomary for Servants to wear the Livery of their Maſters, and others to bear Badges of their Order, Profeſſion, Servility, &c. So in former Ages, and divers Countries, it was uſual to bear Badges, Marks and Signs on divers Occaſions. In *Ezek.* ix. 4. *A Mark was to be ſet on the Forehead of thoſe that lamented the Abominations of the City.* The like was to be done upon them in *Rev.* vii. 3. and ix. 4. So the Worſhippers of the Beaſt, *Rev.* xiii. 16. were to receive a χάραγμα, *A Mark in their right Hand, on their Foreheads.* Thoſe χαράγματα, στιγμάδες, *Badges*, &c. were very common. Soldiers and Slaves bear them in their Arms or Foreheads; ſuch as were matriculated in the *Heteriæ*, or Companies, bear the Badge or Mark of their Company; and whoever liſted himſelf into the Society of any of the ſeveral *Gods*, received a χάραγμα, or a Mark in his Body, (commonly made with red-hot Needles, or ſome burning in the Fleſh,) of the God he had liſted himſelf under. And after

baths ye ſhall keep; for it is a SIGN between me and you, throughout your Generations; that ye may know that I am the LORD, that doth ſanctify you; or as the Original may be render'd, *A Sign to acknowledge, that I* Jehovah *am your Sanctifier*, or *your God*: For as our learned *Mede* obſerves, *To be the Sanctifier of a People, and to be their God, is all one.* So likewiſe very expreſly in *Ezek.* xx. 20. *Hallow my Sabbaths, and they ſhall be a Sign between me and you, that ye may know that I am the LORD your GOD*; or rather as before, *to acknowledge that I JEHOVAH am your GOD.*

The Sabbath being thus a Sign, a Mark, or Badge, to acknowledge God to be their God, it follows, that a Neglect or Contempt of that Day, redounded to GOD; to ſlight that, was ſlighting God; to profane that, was to affront God; for the Puniſhment of which, What more equitable Penalty than Death? And although under Chriſtianity, the Puniſhment is not made Capital, yet have we no leſs Reaſon for the ſtrict

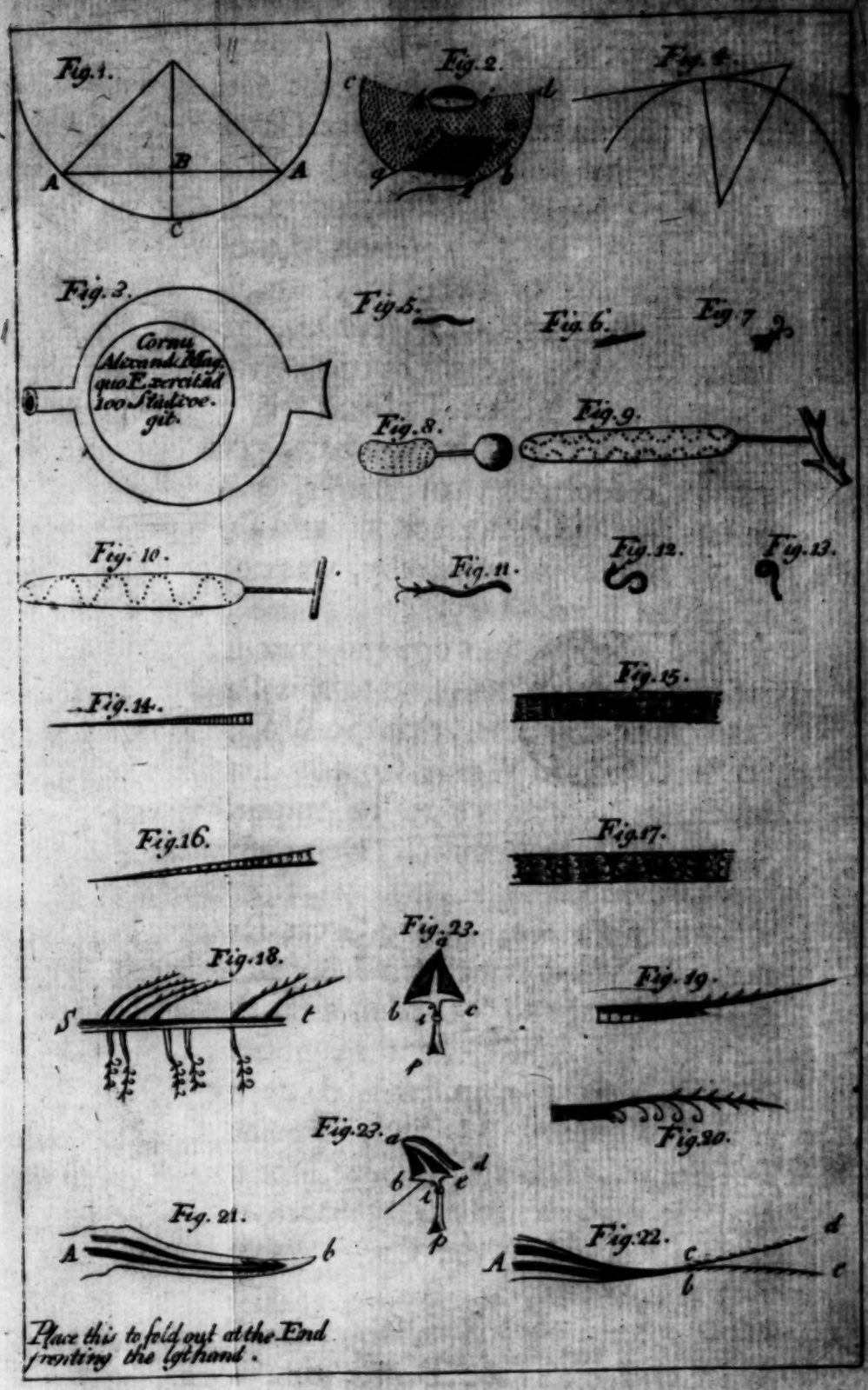
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after Chriſtianity was planted, the Chriſtians had alſo their *Sign of the Croſs*. And not only Marks in their Fleſh, Badges on their Cloaths, &c. were uſual; but alſo the Dedication of Days to their imaginary Deities. Not to ſpeak of their Feſtivals, &c. the Days of the Week were all dedicated to ſome of their Deities. Among the *Romans*, Sunday and Monday, to the *Sun* and *Moon*; Tueſday to *Mars*; Wedneſday to *Mercury*, &c. So our *Saxon* Anceſtors did the ſame; Sunday and Monday, (as the *Romans* did,) to the *Sun* and *Moon*; Tueſday to *Tuyſco*; Wedneſday to *Woden*; Thurſday to *Thor*; Friday to *Friga*; and Saturday to *Seater*: An Account of which Deities, with the Figures under which they were worſhipp'd, may be met with in our learned *Verſtegan*, *Chap.* 3. *p.* 68.

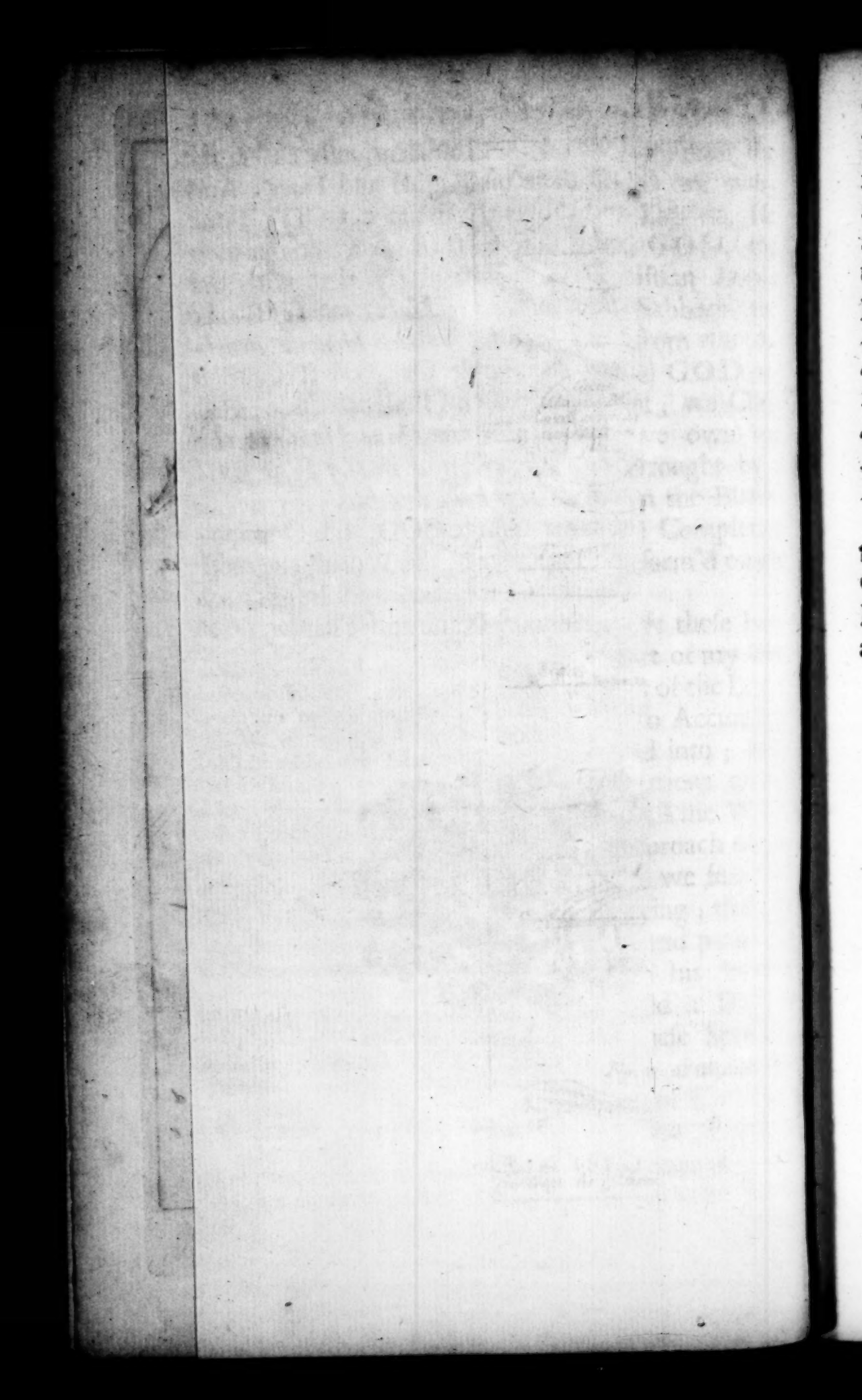
Obſervance of this Holy Day, than the *Jews*, but rather greater Reaſons. For the GOD we worſhip, is the ſame: If after Six Days Labour, He was, by the Seventh, own'd to be GOD, the *Creator*; no leſs is He by our Chriſtian Lord's Day: If by the Celebration of the Sabbath, the Remembrance of their Deliverance from the *Ægyptian* Bondage was kept up, and GOD acknowledged to be the Effector thereof; we Chriſtians have a greater Deliverance, we own our Deliverance from Sin and Satan, wrought by a greater Redeemer than *Moſes*, even the Bleſſed JESUS, whoſe Reſurrection, and the Completion of our Redemption thereby, was perform'd on the Chriſtian Lord's-Day.

And now to ſum up, and conclude theſe Inferences, and ſo put an End to this Part of my Survey: Since it appears, that the Works of the LORD are ſo Great, ſo Wiſely Contriv'd, ſo Accurately Made, as to deſerve to be enquir'd into; ſince they are alſo ſo manifeſt Demonſtrations of the Creator's Being and Attributes, that all the World is ſenſible thereof, to the Great Reproach of *Atheiſm*: What remaineth? But that we fear and obey ſo Great and Tremendous a Being; that we be truly thankful for, and magnifie and praiſe his Infinite Mercy, manifeſted to us in his Works. And foraſmuch as He hath appointed a Day of Purpoſe, from the Beginning, for theſe Services, that we may weekly meet together, commemorate and celebrate the Great Work of Creation, that we may pay our Acts of Devotion, Worſhip, Homage and Fealty to Him; and ſince this is a Wiſe and Excellent Diſtribution of our Time

What



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What ſhould we do, but conſcientiouſly and faithfully pay GOD theſe his Rights and Dues? And as carefully and diligently manage GOD's Time and Diſcharge his Buſineſs then, as we do our own upon our ſix Days; particularly that with the pious *Pſalmiſt*, *We love the Habitation of God's Houſe, and the Place where his Honour dwelleth*; and therefore take up his good Reſolution in *Pſal.* ver. 7. with which I ſhall conclude; *But as for me, I will come into thine Houſe in the Multitude of thy Mercy, and in thy Fear will I worſhip towards thy holy Temple.*

Now to the ſame Infinite GOD, the Omnipotent Creator and Preſerver of the World, the moſt Gracious Redeemer, Sanctifier, and Inſpirer of Mankind, be all Honour, Praiſe and Thanks, now and ever. *Amen.*

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PHÆDRI Cæſaris Auguſti Liberti Fabularum Æſopiarum Libri V. Publii. Syri Sententiæ ex ejus Mimis collectæ multo locupletiores. *Utrumque recenſuit, & Notas adjecit* Samuel Hoadly, *M. A.* Scholæ *Norvicenſis* quondam Magiſter. In uſum Scholarum per totam *Hiberniam.*

Farnaby's Rhetorick.

Solomon's Proverbs *Engliſh* and *Latin,* for the Uſe of Schools.

Corderii Colloquia.

Lilly's Grammar.

Bibles of all Sorts.